Definitions

fMRI - functional MRI; type of MRI used to map brain activity by identifying which regions of the brain are receiving the most blood flow; this in theory translates to the regions of the brain being used.

MRA - magnetic resonance angiography; type of MRI used to measure blood flow through arteries and veins; being used more to identify heart problems.

cine MRI - sequence of MRI images timed with the heart cycle; images can then be combined to form a - *cinematic* - or movie of fluid motion.

sagittal - one of three planes of reference; sagittal image is a side view, like a cross section

coronal - one of three planes of reference; coronal image is a back (or front) view

axial - transaxial; one of three planes of reference; axial image is a slice through the middle at any height so resulting view is from the top

X-ray - An x-ray beam is generated and directed at the imaging target which is placed in front of a film. Very quick and easy to use.

CT - Computed Tomography; patient is encircled by radiation detectors and a rotating x-ray is used to generate image slices. Computer software then creates an image from the data. Capable of generating 3-D images. Most CT scans take 30 minutes or less and are useful for a variety of diagnostics.

Ultrasound - Generates sound waves that are inaudible to humans - 1 million to 20 million cycles per second - and detects the reflection of the sound waves off of body parts to generate an image. Growing number of uses.

PET - Positron Emission Tomography; creates images of brain activity by measuring the radioactive decay of a substance injected into the subject; cells

Magnetic Resonance Imaging

Whether it's an experience to dread or you're the type of person who falls asleep during it, the fact is that MRI's are a way of life for Chiari and syringomyelia patients. During the first year of my diagnosis alone I endured 4 separate sessions in the beast, each one involving both a cervical and thoracic scan. After surgery, the MRI's slowly tapered off from every 6 months to every couple of years. The longest I've been in a machine in one sitting is for a little more than 2 hours as part of ongoing research.

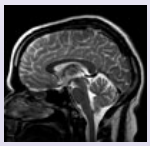
Some people don't mind the scans - I tend to fall asleep, but then I twitch in my sleep and the techs wake me up to tell me not to move, and some people freak out - I've spent what felt like an eternity in the waiting room while the person before me was being talked into the machine and then finally sedated.

No matter where you fall on the spectrum, have you ever wondered how lying in that machine can create such amazing images of your spine and brain? Next time you're in the machine for a scan consider the following...

The MRI

MRI's have become tremendously popular over the past few years, with imaging centers literally popping up everywhere. Their popularity is fueled by their usefulness in diagnosing a range of diseases and injuries, from neurological disorders like CM/SM to torn ligaments in the knee. Combined with their safety and the rapidly advancing technology, MRI has become the diagnostic tool of choice in many medical situations.

Magnetic resonance imaging is aptly named because the process involves magnets (as everyone knows), resonance (think vibration), and imaging (creating pictures). The MRI machine is essentially a big magnet - most are powerful enough to pick up a car - along with sensing devices known as coils and a sophisticated computer.



MRI works because the human body is composed largely of water and fat, which both contain large amounts of the element Hydrogen. Individual Hydrogen atoms have a magnetic property with a certain direction - think of the way a compass needle points. In general, the magnetic properties of all the Hydrogen atoms are pointing all over the place in a random fashion. However, when a body is placed inside a strong magnet, the magnetic properties of the Hydrogen atoms will tend to line up in the same direction, much like a compass needle points to the North Pole. This is where the Magnetic in MRI comes in. The MRI magnet lines up the Hydrogen atoms in an orderly way.

What happens next is an energy wave (like radio waves) is directed at the Hydrogen atoms. This moves the alignment of the Hydrogen atoms to a different direction. When the energy wave is turned off, the Hydrogen atoms will return to their alignment from the magnet. As they return to this state, they resonate - or vibrate - and give off electromagnetic energy that they absorbed from the energy wave. This is the Resonance in MRI.

Finally, a device known as a coil detects the energy given off by the Hydrogen atoms and sends the information to a computer. The computer uses that information, combined with what it knows about the magnets, and creates the detailed images we are used to seeing. This is the imaging part of MRI.

MRI machines are rated according to the strength of their magnets in units called Tesla (named after the physicist and inventor Nikola Tesla). The stronger the magnet, the better the image quality. High strength machines are considered to be .9T or higher, with the latest generation of products at 3.0 Tesla and even stronger ones in the pipeline.

Advantages OF MRI

One reason MRI has become so popular is the detailed images it can generate of soft tissue in the body. While an X-ray is useful for identifying bone fractures, the MRI can be used examine the structure of the brain, the spine, organs, veins and arteries, and joint ligaments and tendons.

A second advantage of MRI technology is its safety. MRI uses much less energy than an X-ray and there are no known safety issues with being exposed to the magnetic fields generated by an MRI machine. One very important safety precaution however is that people with metal in

which are more active just after the injection will absorb more of the substance. Brain activity is represented visually by using different colors. Used for brain research and to identify the effects of brain diseases like Parkinson's.

MRI Facts

1. There are over 7,000 MRI machines installed in the US.
2. The MRI market - for the actual machines - is over $1 billion in the US annually.
3. A typical high field strength MRI unit will cost more than $1.5 million dollars
4. GE Medical Systems is the largest MRI vendor in the US, with 36% of the market.
5. Other major vendors include Siemens and Philips.
6. Over 20 million MRI procedures - or scans - will be performed in the US in 2003.
7. The cost for the type of scan that a CM/SM patient receives is usually around $1,000.
8. Many CM/SM patients undergo more than one procedure per session.
9. Open MRI's, while less claustrophobic, may not generate images of suitable quality for CM/SM patients.
10. The Food and Drug Administration (FDA) regulates all medical devices, including MRI's and their accessories.

their bodies - such as aneurysm clips, orthopedic implants, etc. - may not be able to use MRI. The strong magnet can move metal which is in the body causing damage to the tissue around the metal. This is why MRI technicians ask a patient a laundry list of questions before every scan.

Because of it's versatility, researchers (radiologists and medical physicists) are constantly developing new applications and finding new uses for MRI technology. Recent applications include using MRI to visualize blood flow and diagnose cardiac problems, and functional MRI which identifies brain activity based on how much blood is flowing to a particular part of the brain.

Unfortunately from a patient's point of view, the MRI, while safe, is not the most comfortable of tests. MRI units are very cramped and some people feel claustrophobic while inside. Procedure times are long and patient's must be very still while being scanned. Injected contrast agents and coils that look like Hannibal Lechter's mask in Silence of the Lambs add to the discomfort. In general, the rooms are cold and the magnets in the machines are very loud as they turn on and off, so ear protection must be worn.

However, according to David M. Weber, Ph.D., Manager of GE Medical Systems Global High Field MR Business, the machines have come a long way in patient comfort, "Patient comfort is a very important design consideration in GE MRI products. All of the high field cylindrical MRI scanners are equipped with a full 60 cm patient bore, with wide flared openings at either end. This, combined with an ultra-short design, significantly reduces the claustrophobic response that was associated with MRI of a decade ago. We have also developed an option for our high field scanners that we call "Quiet Technology". With this, we are able to reduce the acoustic noise of the MRI scan by about 40%."

MRI And Chiari/Syringomyelia

MRI technology has had a dramatic impact on the diagnosis and understanding of Chiari and syringomyelia. Once thought to be extremely rare, MRI has shown these disorders to be more common than previously thought. With MRI now capable of showing CSF flow, the very definition of Chiari is changing and the focus is shifting from the size of the herniation to one of CSF blockage. MRI can help surgeons both plan surgery and assess their work afterwords. On the research side, as can be seen in this month's In The Spotlight, the MRI is a valuable tool in furthering our understanding of the cerebrospinal system and how syrinxes form and grow.

Hopefully, future advances in MRI technology will have an even greater impact. "MRI is continually getting faster and faster," notes Dr. Weber. "Exams that once were 1 to 1.5 hours are now routinely done in a half hour or less. Continuing advances in the hardware and software of MRI scanners will bring further increases in the speed of scanning - ultimately towards a "real-time" MRI examination. We will then not only be able to complete today's MRI exams in just a few minutes but also use the MRI to visualize very rapid processes in the body such as the beating heart, the breathing lungs and even the thinking brain. In other words, we will be able to capture living processes rather than just static images of anatomy."

With the good and the bad, for now and into the foreseeable future, the MRI will be part of Daily Living for the Chiari/syringomyelia community.

Sources: *North Carolina State University web site; Wellesley College web site; Nagasaki University Radiology Dept. web site; Department of Energy web site; European Magnetic Resonance Forum web site; Brigham and Women's Hospital web site.*