THE MAGNETOM

✸ FLASH ✸

newsletter for SIEMENS MAGNETOM users • vol. 2 no. 1/1994

IN THIS ISSUE...

From the Editor

Your support has made the Siemens FLASH newsletter an unqualified success. Your many helpful hints have improved the quality of work being done by your peers across the USA. Your in-depth articles about new techniques help most of us really understand what we are doing, and why. Announcements of upcoming educational events and upcoming system upgrades have kept you in the planning loop. The crossword puzzle challenges your technical expertise while providing some well-deserved fun. Siemens' customers as far off as Asia, Europe, and the Middle-East have requested the FLASH newsletter.

For the FLASH to continue in this manner, it needs your continued support. As the new editor, I am challenging each Siemens customer to send me some tidbit, some article, some announcement, some suggestion or criticism, some success or failure story about your operation. Your "ho-hum" may be another person's "wow". This describes the essence of a newsletter. Although you may think your special technique is trivial or obvious, it's probably neither.

Don't worry about your writing skills. As editor, I'll help you with any minor format or wording changes needed for clarity, but the info must come from you. I'm anxious to hear from you SOON!

The MAGNETOM FLASH

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A2.7 Software Release

MR Division
Siemens Medical Systems, Inc.

- ☑ SP/SP4000
- ☐ Impact
- ☐ P8

Software release A2.7 will soon be available for installation on your Magnetom SP system. A2.7 will be preceded by an educational video, highlighting new features as well as an educational section describing in detail how to use these new features. We encourage you to review the video prior to installation of the software. Once you have reviewed the video, you can schedule with your local service engineer for installation of A2.7 software. Having previewed the video, and the installation of the software is complete, your local application specialist will call and arrange a visit, at a time that is convenient for you. He or she will arrive on site with a defined agenda, to assist you with any questions or problems you may still have regarding the software.

A2.7 Software will soon be released for the MAGNETOM SP. Software release A2.7 adds powerful and practical new applications and enhancements to your Magnetom SP System as well as providing new applications in cardiac imaging.

New pulse sequences will provide the ability to perform breathhold imaging of the coronary arteries. These new sequences have a built-in fat saturation pulse to eliminate the unwanted signal from fat surrounding these vessels and the heart.

There are several options in new cardiac cine studies. By collecting several lines of data per slice per cardiac cycle, cine images can be collected in a breathhold for patients with normal heart rates or slightly longer for patients with faster heart rates.

Software version A2.7 brings several new enhancements in time of flight MR Angiography. Traveling saturation sequences for venous and arterial flow were introduced with A2.5 software. With A2.7, new sequences are available which provide a choice of three different sat band placements: directly adjoining the slice, or one or three slice thicknesses away from the slice. These distance factors are appropriate for different applications in the body.

Bolus tracking measures blood flow velocities. A thin presaturation band perpendicular to the vessel, saturates the blood. This allows you to not only determine the direction of blood flow, but also allows you to measure the distance that the saturated blood travels. The velocity equals the distance divided by the time. You can measure the distance, you know the time (the TE), therefore you can calculate the velocity.

There are new body MRA sequences which use cardiac triggering. The ECG leads will trigger the Magnetom SP's acquisition of single phase or multi-phase imaging of the abdominal or thoracic vessels. These images are collected during breath holding.

New susceptibility sequences, in a new protocol group-HEMO-provides a double echo flash sequence and a single echo flash sequence, both with refocussing. The echo time is variable to increase detection of minute hemorrhagic lesions.

New protocols for existing applications bring additional flexibility, options and enhancements to the Siemens Magnetom SP systems.

Fat Saturation, or FATSAT, uses a frequency selective RF pulse to reduce the signal from fat. Software A2.7 expands imaging possibility with gradient echo 2D and 3D imaging, as well as additional single echo and double echo spin echo sequences.

There are new MPRAGE sequences available which continue to provide high signal to noise, thin continuous slices and multi-planer reconstruction capabilities in significantly less time. New 3D MPRAGE sequences allow for a two hundred millimeter field of view (200 FOV) and a selective excitation pulse to acquire transverse, coronal or sagittal slabs of any area of the body.

There are new and improved protocols for several new coils. Siemens is the first in the industry to introduce a dedicated bilateral coil for imaging of the breast. The new endorectal coil can help the clinician measure the aggressiveness of small prostate malignancies, and the circularly polarized spine and knee coils show improvements in signal to noise by as much as forty percent.

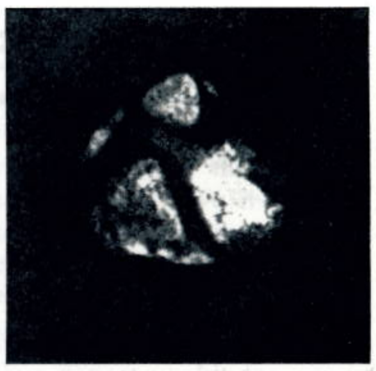
Finally, the Magnetom continues its revolution in system tune-up and quality control testing with enhancements to the Siemens Quality Audit. Additional system analysis procedures can be performed overnight and unattended. This means that scheduled maintenance has less impact on the daily routine and on patient throughput.

Software version A2.7 for the Siemens Magnetom SP systems continues the Siemens commitment to enhanced imaging, patient comfort and ease of operation.

MR Angiography utilizing new optimized traveling SAT.

Fat Saturation with gradient-echo contrast in the knee.

Bolus Tracking study in the liver.



Breathhold imaging of the coronary arteries.

Software Distributions

Siemens Medical Systems, Inc.

- ☐ SP/SP4000
- ☑ Impact
- ☐ P8

As a manufacturer of technical medical imaging equipment, in particular magnetic resonance imaging equipment, Siemens Medical Systems recognizes a certain amount of responsibility to educate and instruct our customers in the use of this equipment. Effective training on the equipment means more productive use of the equipment. However, in today's environment, where the main focus is centered on revenue, it happens all too often that essential training takes a back seat to the "patient schedule". Unfortunately, not only does the manufacturer lose when this happens, but you, the customer, lose as well. If only departments would realize that time spent on education can never be wasted time, ultimately everyone benefits. As magnetic resonance continues to expand technologically, education and training will take on an increasingly stronger role.

Keeping in mind the importance of well trained technologists, while also keeping in mind concerns regarding revenue, Siemens has begun to implement some changes in training for new software.

A1.3 software for the Impact, as well as A2.5 software for the SP were distributed with informational videos describing the new features. However, A1.5 software for the Impact was the first software distribution which was preceded by an educational video, whose primary purpose was to improve the time from release of the software to installation at the customer site. Distributing the software with an educational video included with it permitted several positive actions to take place:

•The customer was able to schedule software installation at a time that was convenient for them, their patient schedule and the technologist's

... continued on page 6

Detecting Breast Cancer in Women

A new clinical study, set to begin in September, will examine the role of contrast-enhanced Magnetic Resonance Imaging (MRI) in diagnosing breast cancer. The project will be conducted in the United States and Europe by the Medical Engineering Group of Siemens AG in cooperation with eight medical research institutions specializing in breast diagnosis.

Schering AG, Germany, will make its Magnevist (Gd-DTPA) contrast medium available, and is involved in project organization. Berlex Laboratories, Inc., Schering AG's U.S. pharmaceutical subsidiary, will be responsible for clinical studies in the United States.

The study will be conducted over a two to three-year period, with approximately 2,000 women taking part in Sweden, the Netherlands, Germany and the United States. The findings will be collectively evaluated by experts in the fields of X-ray, Mammography, Magnetic Resonance Imaging and Pathology.

Three leading experts have agreed to join the project and will serve as advisors in all aspects of the study-from its design, through final interpretation of the data. They are: Dr. Roland Holland, National Breast Screening Center, Nijmegan, the Netherlands; Dr. Laslo Tabar, Central Hospital, Falun, Sweden, and Dr. Edward Sickles, University of California, San Francisco, U.S.A.

The study is designed to clarify and define the role of contrast-enhanced MRI in breast diagnosis. The results may influence further developments in MRI technology; including potential development of special MRI systems for breast imaging, and the reimbursement policy towards breast MRI.

Results leading up to the study suggest that together, MRI and X-ray mammography will provide physicians with information for a more accurate diagnosis. This would be a tremendous benefit since breast cancer is the leading cause of death among women between the ages of 35 and 55 in industrialized countries.

In July, 1992, Siemens was the first manufacturer to deliver a dedicated MRI breast coil which can provide the image quality necessary for this study. In 1988, Schering AG, Germany, introduced the MRI contrast medium Magnevist (Gd-DTPA), which is marketed in the U.S. by its subsidiary Berlex Laboratories, Inc.

The study will attempt to determine whether MRI, used with this widely available contrast medium, will provide physicians with the information necessary to recognize and differentiate between benign and malignant lesions.

The milestone project marks another important contribution to the research activities of both Siemens and Schering in the field of MRI.

Results of the study will be of particular interest to the users of the more than 7,000 MRI systems throughout the world. As one of the pioneers of MRI technology, Siemens AG, Berlin and Munich, has installed more than 1,450 of its MAGNETOM Magnetic Resonance Imaging systems worldwide.

MR Applications Support Line 1/800-333-3137

In the past two years, the MR Applications group has implemented many new customer support features:

- Our applications staff has increased by almost 50%.
- We increased the number of MR technologist seminars from one to two a year (Siemens pays for the hotel stay for one technologist from each site!).
- Several Users Meetings held regionally throughout the United States
- Educational videos sent out prior to the release of software, etc.

One support mechanism which had been constantly in demand was an 800 number for applications support. In October 1992, Siemens Medical Systems initiated the MR Applications Support Line. Use of this service started out a bit slow, but has met significantly with increasing volume. Since the initiation of this service, daily calls have increased from an average of four calls per day to almost thirty calls per day.

Unfortunately, the current call handling procedure does not allow for this type of volume. Currently, there are four lines which are able to take incoming calls, one being direct to the application specialist on call, and the other three to a recorder. At times, however, this is still not sufficient to support the volume of calls coming in. Also, many questions or problems which require a response are incapable of being answered in a couple of minutes. Some calls can take as much as forty-five minutes to resolve, thereby not allowing for quick and expedient responses to other calls which have been left on the recorder during that time.

It is obvious that changes and modifications are needed to properly support you with your questions and problems. Your patience is requested while enhancements are underway to improve the support and response time of the 800 number. Approximate time to completion of these added features is early March, 1994. Details will follow on the next issue of The MAGNETOM FLASH.

In the meantime, we ask the following of those using the 800 number; Please remember to leave your name, site name, telephone number and magnet type. We will frequently receive calls without a name or telephone number, making it very difficult to call back the person or facility who placed the call. If for any reason you do not receive a call back once you have left a call on the recorder, please fax your question on a piece of paper to MR Applications, at Fax number 908-632-2813. Remember to include your name, site name, telephone number and magnet type.

MRI Desktop Organizer

- Handsomely crafted in durable poly-resin
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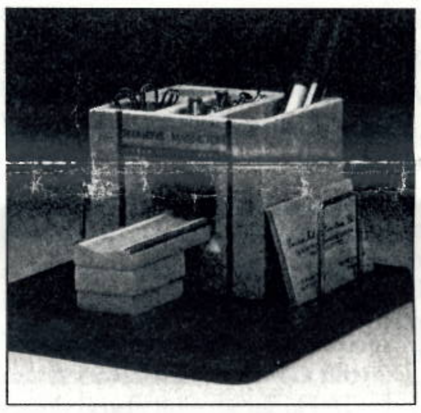
- Customized, with your facility's name, address and telephone number for immediate physician I.D.



For additional information please call (718) 544-7994
Creative Medical Promotions Ltd
105-05 Metropolitan Avenue,
Suite 216
Forest Hills, New York 11375

MRA Award

Gerhard Laub, a Senior Scientist with Siemens AG, was awarded a Gold Medal for Pioneering in MR Angiography (Time of Flight) at the 1993 SMRM in New York City.

Dr. Laub has been working in the development of MRA as well as other cutting edge MR applications for many years, and has published numerous papers concentrating on MRA. Dr. Laub joined Siemens in 1986.

Reminder!

Approximately one year ago the Applications Group produced a binder to hold the Applications Updates. If you did not receive one and would like one, please send a telefax to:
MR Applications Group at (908) 632-2813. Please include your name, site name, and address.

Additional Applications Support

With the implementation of the 800 number for applications support (1-800-333-3137), we have also received requests for additional types of applications support. Namely, requests of names and telephone numbers of other technologists you can contact from other sites who may have expertise in a certain area. Technologists names, Site name, telephone number and area of expertise are listed below.

Name	Site	Tel Number	Area of Expertise
Clampitt, Mark	Univ. Hosp. of Cleve.	216/844-7750	SP - general
Greene, Robin	Univ. of Kentucky	606/287-8252	SP - cardiac, MRA, spectroscopy
Harris, Christine	Child. Hosp. of Phila..	215/590-4120	SP - general, pediatrics, MRA, cardiac
Lanigan, Tim	Beth Israel Hosp.	617/735-2247	Impact - general
Lee, Ralph	UCSF/VAMC	415/750-6919	SP/Impact - MRA
McCurdy, Michael	Memorial Med. Ctr.	310/426-2928	SP - pediatric, MRA, breast imaging, contrast media
Stevenson, Jeff	NYU	212/263-7195 (beeper 1501)	Impact - MRA difficult cases
Walling, Jim	Hoag Memorial Hosp.	714/760-2388	General
Shelley, Mindy	VA of Greater Dayton	513/461-1455	SP4000/Impact - pediatrics, general
Hodges, Mike	Radiology LTD	602/721-4337	Impact - general

Siemens Applications

Below is a picture of two Siemens Applications Specialists hard at work. Applications is a lot of hard work, but at Siemens, a lot of good fun is always part of the bargain. Can you name these two applictions specialists?

Enhance!

Our installed base has grown dramatically over the past 2 years, and we have initiated the ENHANCE program to help you with your marketing needs.

The ENHANCE program offers a start-up kit for new sites and the opportunity for our installed base to tap into its resources: videotapes, slide sets, brochures and exhibit booths.

Enhance

The chief technologist at every MAGNETOM site should receive a copy of the catalog this month. Please pass it around your department!

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Clinical Applications of Fat Suppression Techniques

☑ SP/SP4000
☑ Impact
☑ P8

Principles and Clinical Applications

Richard Patt, M.D. – Georgetown University Medical Center – Washington, D.C.

Clinical applications for fat suppression techniques remained relatively limited until two major advances in the last few years improved these techniques: improvement in RF pulses and shimming for chemically-selective FATSAT, and the increased speed and number of slices made available with Turbo Inversion Recovery (TIR) sequences. These two techniques are currently the most commonly used in routine clinical scanning and display a wide range of utility. While both FATSAT and TIR are able to provide significant suppression of signal from fat protons, these techniques are not interchangeable for all applications. In most cases, one or the other technique provides the best information; however, in some applications, using the wrong technique can lead to insufficient or incorrect diagnostic information.

If one is interested in evaluating gadolinium contrast enhancement characteristics of an area within or adjacent to fat in the body, FATSAT is the technique of choice. In general, pre- and post-contrast scans of the same area are performed using a T1-weighted FATSAT sequence. Since the high signal from fat is eliminated from the image, the image gray scale is automatically shifted and structures with a high water content become bright (bladder, blood vessels, bowel contents, etc.) The pre-gadolinium scan ensures that these normally bright structures are not confused with enhancement following gadolinium injection.

In abdominal imaging, FATSAT decreases respiratory motion artifacts by removing the bright signal from fat. This also has the effect of increasing the relative signal-to-noise ratio while providing standard spin echo imaging signal characteristics.

T2-weighted FATSAT appears to have fewer clinical uses, but has been helpful in pelvic imaging. In evaluating the periprostatic neurovascular bundle in patients with prostate cancer, TSE-T2 FATSAT has aided in the detection of tumor extension outside of the capsule of the prostate gland. It can be helpful in imaging ovarian and other adnexal masses. Imaging the orbits may also benefit from this technique.

FATSAT is not a perfect technique. It is highly dependent on magnetic field homogeneity. Individual patient shimming is becoming easier to perform with improved automation of shim programs. Performing FATSAT on regions away from isocenter such as shoulders, breasts, brachial plexus, etc. can often provide suboptimal results. It remains an operator-dependent technique, and if improperly performed can lead anywhere from uneven or no fat saturation, to partial or complete water saturation, depending on the frequency offset chosen.

Inversion recovery sequences may be used when suppression of fat signal is needed without gadolinium enhancement. These sequences provide heavily T1-weighted images. Until the ready availability of TSE IR pulse sequences, this technique was somewhat limited due to its longer imaging times and limited number of slices available, both dependent on the inversion time (TI) used. And as stated earlier, with the TI selected for fat suppression, the sensitivity for T1 changes is too low to be used with gadolinium. In fact, gadolinium administration may actually result in a "negative enhancement effect" on IRABS sequences.

There are positives and negatives to both types of fat suppression imaging,. What is most important to remember is that these are usually not interchangeable for all clinical applications. Understanding the advantages and limitations of each technique is the key to choosing which one will provide the best diagnostic images.

Neuro Imaging

T1-weighted FATSAT is useful in evaluating intraorbital lesions, especially those adjacent to the optic nerve or orbital muscles. As with other lesions adjacent to fat, enhancement following gadolinium injection can be obscured using a standard T1-weighted pulse sequence. However, by suppressing the signal intensity of fat adjacent to the pathology, enhancement is much better detected.

In the spine, T1 FATSAT following gadolinium is also useful in detecting metastasis. One must realize, though, that using the same pulse sequence without gadolinium can actually make lesions within the bone marrow less apparent. The same technique can be used in the brain to evaluate lesions involving the bones of the skull.

Body Imaging

Use of both precontrast TSE IR and postcontrast FATSAT in the neck can aid in detecting abnormal pathology such as adenopathy, primary tumors, abscess, thyroid abnormalities, and post-operative changes. In patients with suspected thyroid pathology, gadolinium-enhanced FATSAT has the advantage of not affecting possible radionuclide therapy uptake (if required) as would using iodinated contrast with a CT scan of the neck.

In the chest, FATSAT or TSE IR can be used (as it can in any part of the body) to determine whether a mass seen on standard T1-weighted imaging is composed entirely of fat; i.e. a lipoma. These are often present along the chest wall, but may be found in many parts of the body.

We have found that TSE IR sequences have occasionally been helpful in imaging the brachial plexus to better image the cords and trunks of the plexus itself by decreasing surrounding fatty signal. As this may require large fields of view over 400mm in the coronal plane to image out to both axillae, FATSAT can be less effective due to difficulties in obtaining homogeneous saturation in the lateral aspects of the magnet bore.

Breast imaging for the evaluation of cosmetic or reconstructive implants with the bilateral breast coil is a highly effective tool in diagnosing implant leak or rupture. Depending on whether single or double lumen implants are used, saline or silicone, and the mixing that can occur between silicone and saline in double lumen implants if they are ruptured, complex signal characteristics can be observed. Silicone has a T1 between fat and water. We can take advantage of this fact and, using TSE IR, select a TI that will not only null fat (TI = approx. 120-150msec) but use a TI of approximately 400msec to null the signal from silicone.

Thus, in imaging patients with breast prostheses, we perform both a "fat null" and "silicone null" sequence. The fat nulling sequence allows us to better examine the margins of the implant shell for small silicone leaks. Silicone nulling tells us whether masses along the implant are related to breast tissue or represent silicone outside a ruptured implant by behaving signal-wise the same as silicone inside the implant. Gadolinium is of no clinical benefit in the evaluation of patients with breast implants. FATSAT can be used precontrast, but due to the position of the breasts in the magnet bore, TSE IR provides more reliable suppression of fat signal from patient to patient.

Abdominal imaging has long been

PRE CONTRAST

plagued by the artifacts caused by motion of fat not only internally but circumferentially in the subcutaneous tissues around the body. Restraining belts, anterior saturation bands, and other means to decrease these artifacts have been used. Obviously, the ideal would be just to rid ourselves of the fat signal. IRABS imaging for liver lesion detection was used extensively with some success. Adequate resolution and slice number in a reasonable time period remained a problem until the availability of Turbo IR sequences. We tend to prefer FATSAT, however, in the upper abdomen. The signal characteristics are less complex than IR sequences, and resolution can be maintained with adequate signal to noise similar to standard SE sequences.

Precontrast FATSAT has been used to evaluate the adrenal glands, as these small structures can sometimes be all but obscured by surrounding fat on standard SE sequences. If an abnormality is found, gadolinium is administered and post-contrast FATSAT images in the same area are then obtained.

While imaging lesions within the substance of the liver does not necessarily benefit from the use of FATSAT, detecting small masses in the peripheral portion of the liver, adjacent to fat in the abdomen, is greatly improved by post-contrast FATSAT. Similarly, this same technique can be applied to masses along the peripheral margins of the kidneys.

Pre- and post-contrast T1 FATSAT is useful in imaging pancreatic masses, while TSE IR imaging may be satisfactory for imaging the spleen, when combined with standard SE sequences.

T1-weighted post-contrast FATSAT has also been used in the abdomen and pelvis to evaluate intrinsic bowel abnormalities, such as Crohn's disease and ulcerative colitis. These patients should have nothing by mouth for approximately 6 hours prior to the exam to decrease bowel motion. Post-contrast images are made immediately after a bolus of Gd-DTPA through the area of suspected bowel abnormality and show abnormal enhancement patterns in these areas.

In imaging the female pelvis, TSE IR has been used to show excellent zonal architecture within the uterus. Post-contrast FATSAT may be helpful to better distinguish tumors that spread into the adjacent pelvic fat, however. FATSAT also is helpful in minimizing the chemical shift artifact seen adjacent to solid pelvic organs when using relatively low bandwidth

POST CONTRAST
FAT SATURATION

sequences. In particular, this aids in better evaluating the ovaries as these small organs (much like the adrenals) are surrounded by fat and the outer margins may be obscured by chemical shift artifact on standard SE sequences.

Scanning the male pelvis for prostate carcinoma staging is usually performed without gadolinium, as the prostate is a relatively poor vascular organ and little benefit is obtained by using contrast. Accurate staging to determine appropriate therapy (surgery, radiation, or hormone therapy) is in part determined by MR's ability to evaluate the margins of the prostate gland for tumor spread into the adjacent pelvic fat. High resolution TSE IR appears very helpful in this routine evaluation, and can show impressive zonal anatomy within the gland itself.

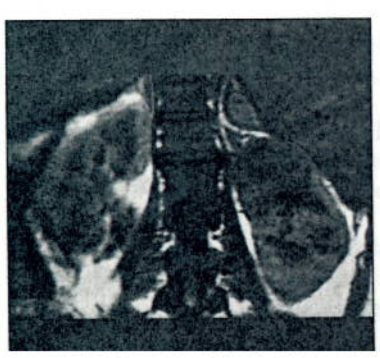
Musculoskeletal Imaging

In adults, fat occupies the majority of the bone marrow space. While this enables us to see the dark bony cortex well, it makes the detection of lesions within the marrow often difficult. TSE IR has been used quite successfully to detect metastatic deposits in the marrow, microfractures not seen on plain film, infection (oseomyelitis), and other abnormalities. Again, the more standard signal characteristics of FATSAT make it often the better choice for detecting and evaluating lesions within the bone marrow. This must be performed with and without gadolinium, unless T2 FATSAT is employed.

Precontrast FATSAT is also used to depict the cartilage in joints, seen as a bright thin line superficial to the cortex of bone in the knee, hip, shoulder, etc. This is due to the fact that joint (articular) cartilage has a relatively high water content which stands out against the black appearance of cortical bone.

In any case of soft tissue mass that involves bone, muscle, or adjacent tissues, pre- and post-contrast FATSAT should be routinely performed. They add information about tumor extent, additional lesions in surrounding bones, invasion of surrounding tissues, etc.

Before using any of these techniques, it is important to understand their limitations and attributes. While this is not meant to represent a comprehensive use of these fat suppression techniques, it can be used as a starting point to apply these sequences in the clinical realm. New applications such as breathhold 2D FLASH with FATSAT in the abdomen and 3D gradient echo FATSAT sequences will further increase the use of these techniques.



Fat Suppression In Magnetic Resonance Imaging

☑ SP/SP4000
☑ Impact
☑ P8

Helmuth Schultze-Haakh, Ph.D., Siemens Medical Systems, Inc.

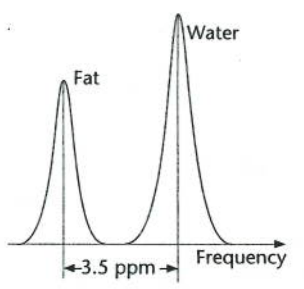
When acquiring an MR image all hydrogen ions or protons whether in a water type environment or in a fatty one will be excited simultaneously. Therefore, both fat and water give relatively strong signals. This could lead to difficulties distinguishing small lesions in a fatty tissue (e.g. around the optical nerve) when using a T1-weighted contrast image, or fluid compared to other bright tissue (e.g. in the joints) in a T2-weighted contrast image. For this reason it is often important and becoming more common to suppress the fat without disturbing the other tissue signals.

There are a variety of techniques to suppress fat. Some are based on the difference in the resonance frequency of fat and water and others on the difference in the relaxation time (T1).

FATSAT

The now most common and most successful technique is FATSAT (fat-saturation). This technique is based on the fact that fat and water protons have different oscillation frequencies depending on the chemical environment of the protons.

Fat and water display two distinctive peaks. These peaks are separated by a certain frequency. To make this separation independent of the system's operating field strength a dimensionless unit is used to describe this difference; it is expressed in parts per million (ppm), and is calculated as the fat-frequency minus the water-frequency divided by the water frequency. This difference is about 3.5 ppm which translates to about 147Hz for a 1T system and 220Hz for a 1.5T system.



A special rf-pulse excites the protons in fat, off the water resonance and thus leaving the water protons unaffected. This acts similar to the spatial presaturation commonly used in spine imaging or MRA. Here, however, this saturation rf-pulse does not excite a spatial region, but rather a certain frequency away from water. This pulse must therefore show a very narrow range in frequencies or bandwidth in order to avoid hitting the protons in water. The SP systems actually use an off-frequency pulse which can be adjusted by the user in A2.5. A1.5 for the Impact systems includes a set of FATSAT sequences which saturate the fat by exciting both fat and water using a shallow rf-pulse, then letting the spins relax for a while which leads to a dephasing between fat and water since the spins are at different frequencies (see phase cycling below). Subsequent rf-pulses will bring the water spins into the transverse plane and the fat spins into the longitudinal plane where they will have no contribution to signal. By using a similar excitation, water can be suppressed instead of fat.

New automated shimming procedures and more reliable selection of fat saturation frequencies will make these techniques just as easy to use in the near future as the standard spin-echo sequences.

Homogeneity

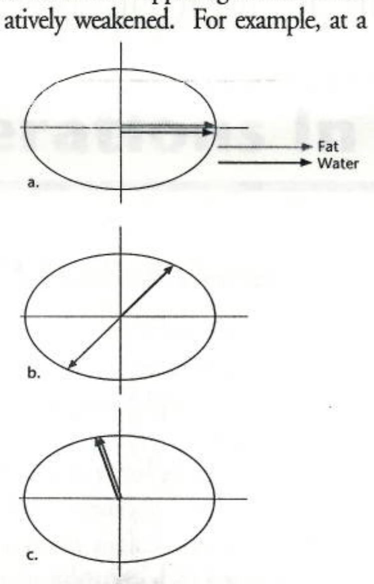
As mentioned the fat and water frequencies are very close together and under normal imaging conditions the rf-pulses span a large enough range to excite both at the same time. In general, the oscillating resonance frequency of the spins is proportional to the magnetic field strength they experience. Any deviation of the field causes some spins to resonate at different frequencies than other ones in the area. This is not just due to the chemical environment of the spins but rather due to the fact that the field is not the same everywhere in the imaging area. The accuracy of the magnetic field is called its homogeneity. Slight deviations in the magnetic field causing differences in resonance frequency similar to that of the fat-water separation can be observed leading to an incomplete fat-saturation or an unwanted saturation of water in some other areas in the field when fat-saturation is used. It is therefore essential to obtain a very good magnetic field homogeneity in the area of interest by shimming the field carefully, ideally with the patient already positioned for imaging. This would make the field everywhere in the area of interest the same and hence the associated frequency of the spins residing in the same tissue. It should be clear that the success of a fat-saturation study depends largely on how well the magnetic field is shimmed. (The shimming procedure of the SP systems is described in the operator's manual.)

Phase cycling

Immediately after excitation the position of fat and water in the transverse plane is the same, they are in phase. However, since the spins experience different frequency water is "running away" from fat. The net magnetization decreases and will have a local minimum when fat and water oppose their phase orientation. After a while, however, water will "catch up" with fat again and their signal increases as they come back into the in-phase condition. This process is called phase cycling. The time period it takes for fat and water to reach the in-phase condition is the reciprocal of the separating frequency: 4.5ms at 1.5T and 6.8ms at 1T. In between fat and water are opposing.

As the echo time in a gradient echo sequence acquisition is increased some oscillation overlaying the T2* decay curve can be observed. Every time fat and water are in-phase a peak appears and whenever they are opposing a local minimum can be seen.

This fact can also be used to reduce the fat signal compared to water. If an echo time (TE) is chosen such that fat and water are opposing then fat is relatively weakened. For example, at a TE of 10ms fat and water are nearly in phase at 1.5T and nearly opposing at 1T. This is the reason why a TE of 10ms is used for MRA at 1T and correspondingly 7ms at 1.5T since a strong fat signal is undesirable.



Dixon Method

The "Dixon Method" also uses the fact of phase cycling. In a spin echo sequence two echoes are formed one which has fat and water in-phase (W+F) and one where they oppose (W-F). If the two images are added to each other (W+F+W-F=2W) a water image can be created and fat is suppressed. If the two images are subtracted from each other (W+F-W+F=2F) a fat image can be calculated. However, this additional post processing makes this technique somewhat tedious. It is also relatively sensitive to patient motion. Since the advent of rf selective FATSAT this technique is less popular.

IRABS

Since fat has one of the shortest longitudinal relaxation times or T1-values in the body, it relaxes relatively quickly. Starting out with a 180° rf-pulse all spins are brought into the opposite direction. As they want to be in the stable parallel direction with the external magnetic field the spins are going to relax passing the transverse plane on their way to regain signal in the longitudinal direction. If a normal spin echo excitation (90° pulse) is used to bring the spins into the transverse plane, right at the time when the fat spins are in the transverse plane, no signal is picked up by fat. Therefore, fat will remain dark. The time between the 180° inversion pulse and the 90° excitation pulse is called the inversion time (TI). Typical values for TI in a fat-suppression inversion recovery sequences are 100 to 150ms. Using longer values for TI (greater than 1500ms) one can also suppress fluid. Using a long TE and a very long TR (greater than 5000ms) this technique has been termed FLAIR (FLuid Attenuated Inversion Recovery).

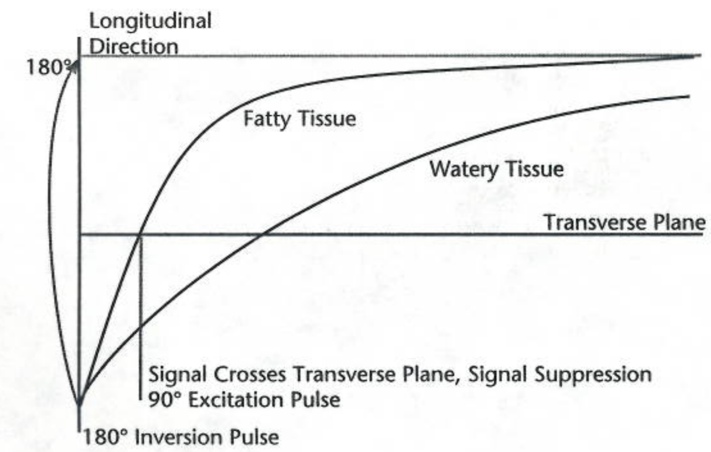
There are some problems associated with IRABS:

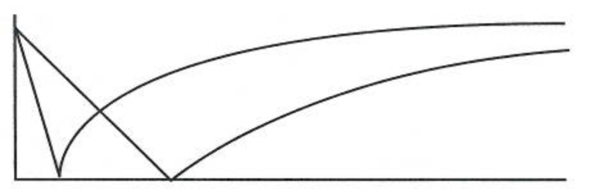
a. To obtain a good steady state situation for all spins a relatively high TR is necessary. This might make T1-weighted contrast scans difficult and scanning times long.

b. Since the data is reconstructed using only the magnitude or amplitude of the echoe data, some signal values originally beneath the zero line are now flipped to the positive side. This leads to an ill-defined contrast behavior. This technique does not work post contrast since GdDTPA reduces T1 values. As T1 is shortened the "flipped" portion of the curve is lowered and therefore the signal reduced rather than enhanced.

On the other hand this technique has gained some wide use since it does not require the same level of homogeneity as the FATSAT techniques and can be done with standard software and hardware configurations.

Fat-suppression techniques have entered the MRI practice and are becoming more commonplace. New automated shimming procedures and more reliable selection of fat saturation frequencies will make these techniques just as easy to use in the near future as the standard spin-echo sequences. In addition, fat-saturation might even become an option for almost all sequences no matter whether they are spin-echo, gradient-echo, 2D or 3D.





In Magnitude Reconstruction, All Values Are Flipped to the Positive Side

Seminars and Announcements

Following are Siemens users meetings and national meetings for 1994. These meetings enable you to meet other Siemens users, exchange ideas and remain informed in this rapidly evolving field. For information concerning any of the following meetings, please contact Michele McDonald (MR Applications Group) at 908-321-3270.

January 15-16	MRA Workshop San Diego, CA
February 5-6	MRA Workshop Washington, D.C.
February 17-20	2nd Annual MRI Conference for Technologists San Francisco, CA
February 19-26	4th Annual MRI in Clinical Practice Breckenridge, CO
March 5-9	SMRI Dallas, TX
March 19-20	MRA Workshop Dallas, Texas
May 12-14	MR Technologist Seminar Orlando, FL
April 20-23	Fourth Annual Neuroimaging Plus Seminar Key West, Florida
May 1-6	ASNR Nashville, TN

MRI Essentials for Technologists

Hyatt Regency New Brunswick, New Brunswick, N J

January 10-14	June 20-24
February 28-March 4	August 1-5
April 11-15	September 12-16
May 23-27	October 24-28

For registration information concerning MRI Essentials for Technologists, please call 1-800-589-5685.

Case of the Week

With the distribution of this issue, the Magnetom FLASH will start a new feature article, Case of the Week or Most Unique Contribution. The purpose of this feature will be to discuss, share, disseminate, or explain any interesting case, experience, event or occurrence that is different or unique.

I think we all have had our share of interesting experiences in MR. Why not illuminate the rest of us with them?

The following article is the first contribution:

Below are shown images of a patient who recently underwent an MR examination of the brain. The patient was screened appropriately, and no indications were found to defer the MR examination. (i.e. previous surgeries, etc.) However, as the images were processed, and came up on the monitor, there very definitely was something amiss! The patient had no previous history of brain surgery or trauma.

What could be causing the artifact?

Answer:

The patient had used "Ronco's Hair Care Product" for balding men. Ron Popeil's (Vegematic, Pocket Fisherman, etc.) product is a type of spray paint for the scalp to minimize the effects of a shiny cranium. The patient did not experience any localized heating. He was removed from the magnet and provided facilities to wash his hair. After removal of the product, the exam was completed without further incident.

Moral of the story: you can never be too careful what goes into the magnet. Anything that has magnetic properties has potential harm. In this case, luckily, there was no harm. However, tattoos, eye makeup, wigs, toupees could harm the patient or cause objects to be lost in the magnet.

Thanks to Kevin McMannis (AMI/St. Joseph Hospital) and Joe Mueller (Siemens Med. Sys.) for the information and images on this incident.


Brain images showing loss of signal in area of cranium

The FLASH Word Bash!

- Fill in the missing word for each statement.
- The parentheses shows the page that has a clue for that word.
- Enter each word in the corresponding entry below.
- Unscramble the eight encircled letters to find the hidden word.
- Enter the unscrambled word in the box to complete the message.
- First to fax correct answers to 201-812-9199 gets a prize.

Puzzle by:
Philip A. Femano, Ph.D., President
Medical Imaging Consultants, Inc.

1. An inversion recovery sequence which suppresses signal from fat by using a specially selected short TI is called ____________. (4)
2. A technique available with A2.7 with which blood flow can be calculated by using an RF saturation pulse is called ____________ tracking. (1)
3. Siemens AG has formed a research collaboration with Schering AG and eight luminary medical centers to conduct an international study on ____________ diagnosis. (2)
4. New rapid 3D sequences available with the A2.7 software release which provide strong T1 weighting are called ____________. (1)
5. MR Spectroscopy provides an effective method for chemical and ____________ analysis. (6)
6. To facilitate the diagnosis of prostate carcinoma, Siemens has announced the availability of the ____________ coil. (1)
7. In order to introduce you to the features of each new software release, Siemens plans to distribute each software version with an ____________ video. (6)
8. The one-week intensive educational program offered by Siemens in New Jersey is the "MRI Essentials for ____________" course. (4)

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1. _ O _ _
2. _ O _ _ _
3. _ _ O _ _ _
4. O _ _ _ _ _
5. O _ _ _ _ _ _ _ _ _ _
6. _ O _ _ _ _ _ _ _ _ _ _
7. _ _ _ _ O _ _ _ _ _ _ _ _
8. _ _ _ _ _ _ _ _ _ _ O _ _ _ _
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O O O O O O O O
"...the clinical innovation leader"

Answers to last issue's puzzle:

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 MCAT   W  HIQ M  SHUNTS
FDA  S ARRT  U R  Y  PIN
L  HMO A NUMARIS R G  R
A B  R MPR   LF A I MEG
SMRT MRA O  MIP F NMR R
H E    G A  STAGE X  IAC
 A     NEMA  Y R G  H D
OPSIS  E  H PARAMAGNETIC
 RT I RT  AM S D T I  E
 O RECFOV  S SPINECHO N
AS  M  MAGNITUDE SP  MTS
 TONE    DO  R N  T T E
SAR N  M  IMPACT   TEACH
 T ISELIN S  N  ASNR  H
PE C   C LEG C  G  ECHO
8 AVM FISP  NEWJERSEY
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MRA: Technical Considerations in Sequence Selection

Ralph E. Lee, M.A., R.T.
MRI Research Associate, UCSF Radiology Service, VA Medical Center

An important concern in MRA is the choice of either a 3D or a sequential 2D Time-of-Flight (TOF) acquisition approach. Although both approaches rely on inflow of bright "flowing spins" (blood) into a saturated (low signal) imaging region for development of angiographic contrast: each sequence type exhibits imaging characteristic that are distinctly different. A basic understanding of these differences, and of how they can be used to the advantage of the MR Angiographer, can be crucial to the success of an MRA examination.

3D sequences excel in areas of complex vascular anatomy and areas with relatively high rates of blood flow. Areas of this kind would include the carotid arteries and the intracranial vessels. Selection of a 3D sequence provides a higher resolution image than a 2D sequence, particularly when rotated projection (MIP) images are required. However, loss of vascular signal can be a problem in areas of slow vascular flow. This saturation of vascular signal occurs as slow moving blood remains within the acquisition volume long enough to receive multiple RF pulses (the same process used to suppress background signal). 3D acquisitions would, therefore, be expected to lose vascular contrast rapidly in low blood velocity situations such as in the venous component of an AVM or in the distal extremities.

The sequential 2D approach has the advantage of maximizing vascular signal even when flow rates are too slow to effectively visualized with three-dimensional sequences. 2D acquisitions make use of much smaller excitation volumes (thin slices rather than thick slabs). Because the length of the blood's path within the volume is often as short as 1.5 or 3 millimeters, saturation of vascular signal is seldom a problem. This ability to visualize slowly flowing blood can be used to great benefit when examining the slow flowing vessels: and one or more 2D MRA images can often be acquired within the space of one breath hold. Because respiratory artifacts can be minimized in this way 2D sequences are usually selected for imaging in the abdomen. The major drawbacks in 2D MRA are lower resolution than 3D techniques (which renders 2D a poor choice for screening of the Circle of Willis) and a tendency to greatly exaggerate the severity of pathology (which makes 2D alone, without additional 3D sequences, a poor selection for the accurate assessment of carotid stenosis). Despite these limitations, 2D techniques are often the sequence of choice for MRA of cranial veins, abdominal vasculature, and often the only successful technique for imaging the vessels of the feet.

Patient studies utilizing a combination of both 2D (for slow flow) and 3D (for high resolution) acquisitions for imaging complex flow situations like AVMs, and rapid but turbulent areas like the carotid arteries (reference Anderson, Saloner, Lee, et. al. AJNR 13:989-1003, May/june 1992 0195-6108/-921303-0989), appear to provide the best correlation with conventional angiographic and ultrasound studies. Whereas, the 3D TOF approach alone, for high resolution imaging of the cerebral arteries, appears to be the overwhelming preference of MR Angiographers nation wide.

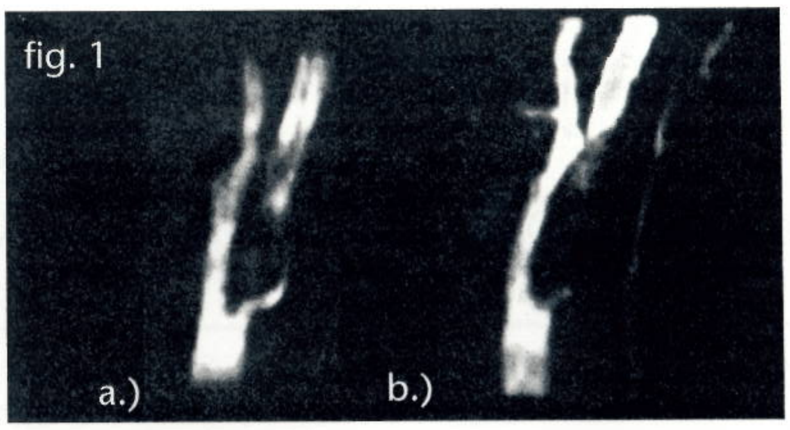

Figure 1: a.) 3D TOF MRA, blood flow is seen passing a large plaque near this patient's carotid bifurcation. Small branches of the external carotid and an ulcer are also identifiable.

b.) 2D TOF MRA of the same patient demonstrates the exaggerated loss of signal distal to a narrowing that is characteristic of the 2D TOF technique.

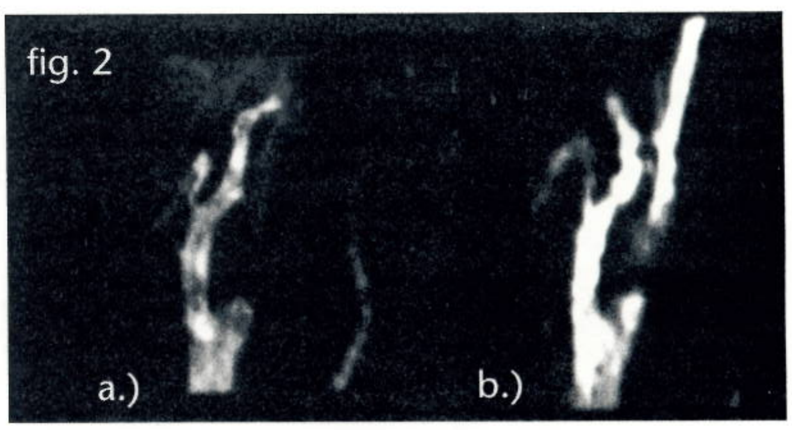

Figure 2: a.) 3D TOF MRA, blood flow signal is lost beyond a near-occlusive stenosis near the carotid bifurcation.

b.) 2D TOF MRA of same patient shows a noticeable loss in resolution but clearly demonstrates the patency of the vessel.

Magnetic Resonance Spectroscopy

Tamara D. Lee, R.T.
Childrens' Hospital of Philadelphia

Magnetic Resonance Spectroscopy (MRS) provides a non-invasive risk free chemical and metabolic analysis of disease states. Spectroscopy has been present since 1666, when Sir Isaac Newton discovered spectrum of colors from a glass prism, ranging from violet to red. The colors represent components of light at different frequencies. MRS has been used since the 1940's in chemical and physical sciences.

With MRS you are collecting the same type of data as with MRI. But with MRI you are producing images with this raw data: no image is being produce when using MRS. Instead we are obtaining a spectrum. In this spectrum you have peaks which represent RF radiation absorbed by nuclei. The area or amplitude of the peak tells the amount of protons in a substance contained in the sample. An increase in the number of nuclei causes an increase in peak intensity. We are able to see signals of protons in substances other than water, and we can tell the difference by the chemical shift values so that the peaks occur in a certain location in the spectrum. Inhomogeneity of field results in broadening of peaks. When inhomogeneity is severe it results in overlapping of peaks. For proton MRS the most common substance in the body is water, and we are looking at the signal in protons of other substances which are present in much lower concentration. Therefore, the water peak must be suppressed.

The other various nuclei routinely monitored with proton MRS are C13 carbon, F19 Fluorine, Na23 Sodium, and P31 Phosphorus. The classical application of P31 MRS is the examination of the bioenergetics of skeletal muscle. Other substances monitored are (cho) choline, (Naa) N-acetyl aspartate, (Cr) Creatine, and (Lac) Lactate. The area of Naa peaks can be related to the number of viable neurons and the area of the choline peaks to cell membranes, while creatine and lactate are indicators for the energy metabolism.

Localization in MRS can be achieved with the following techniques: SE (spin echo), PRESS (Point Resolved Spectroscopy), STEAM (Stimulated Echo Acquisition Method), CSI (Chemical Shift Imaging). All these methods provide 3-dimensional spatial localization for spectroscopy. They also permit selection of the volume of interest based on proton images acquired by MRI with identical patient position. Therefore, an MRS examination can be added after a routine MRI examination. Clinical MR spectra are always displayed together with proton images indicating the anatomical location of the volume of interest selected for spectroscopy.

MRS is proving itself useful as an in vivo tool for medical diagnosis and treatment applications. It is clinically useful in diagnosis of metastatic breast cancer, brain tumors and cerebral infarctions. It also differentiates necrosis and spreading tumor. Routine CT and MRI do not distinguish between the two. Evaluations are also being performed on the brains of pediatric patients indicating both a research and clinical investigative role for MRS. In the future, the clinical indications for spectroscopy are brain tumors, metabolic disease, head injury, stroke and a wide variety of diseases affecting the white matter or associated with developmental delay. Even though spectroscopy in the pediatric brain is in its infancy, its value is obvious in evaluation of in vivo biochemistry.

Magnetic Resonance Spectroscopy is a modality still in evolution. The ability to correlate biochemical markers to imaging findings opens up a new era in research with magnetic resonance imaging. There are investigative protocols performing multiple voxel studies using CSI allowing a comparison of normal and pathological tissues in one acquisition.

A1.5 Software Distribution

. . . continued from page 1

schedule as well.

- The application specialist was scheduled when it was convenient to the customer and their patient schedule.

The educational video provided an overview of what was new, and allowed one to be informed about how to use the new features and applications in the software. When the application specialist arrived on site, the technologists already had a working knowledge of the new software and could use their time more effectively with the application specialist.

A feedback card was included with the video asking the reviewer to rate the effectiveness of the video as well as whether they would support future software releases being distributed in this fashion. The response from our customers was very positive and supportive. Significantly so in fact, that we will continue to distribute software with a pre-released educational video.

There were three main concerns which were disclosed from the reply cards:

- The video was received well, but it needed to have a stronger educational component.
- Arrival of the video at the customer site and customer review of the video must occur prior to installation of the software.
- The video does not replace a live and breathing application specialist, but is a viable second choice.

Steps being taken to address these issue are: the next videos will have a stronger educational/application component as well as be distributed with additional educational material. Some how-to or step by step procedure information for more involved applications will be included. Videos will be distributed two weeks to one month prior to receipt of the software and sent directly to the customer site. Lastly, we recognize how important the applications visit is to most of you, and it should be clearly understood that the MR Applications Group and Siemens Medical Systems will completely support anyone not wishing to accept installation of software without a previously scheduled application visit. Our goal is to shorten the time from availability to implementation.

If you prefer to receive the software with a scheduled applications visit immediately after installation, please communicate this to your local service engineer or sales/product specialist. We will then schedule all events to occur simultaneously, at a time that is mutually convenient.

A2.7 software for the Magnetom SP will be the next version of software released with an educational video as well as educational material. It will also have an enclosed reply card. Please take the time to fill out the card and mail it in. We want to know your comments so we can continue to improve our methods in the future. In addition, if you mail in the card and include your name and address, you have the chance of winning a free, all expense paid trip to the next MR Technologists Seminar. So, please take the time. You never know, you could be a winner!

THE MAGNETOM

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