SIEMENS

Vol. 4 No. 4 1996

The MAGNETOM Flash

Newsletter for Siemens MAGNETOM Users • October, 1996 • $3.50

IN THIS ISSUE

FROM THE EDITOR

This issue is largely focused on the open architecture low field MAGNETOM Open system which is gaining tremendous acceptance in many areas. Two Siemens users present their case report on an MR-guided tumor biopsy performed with the recently released MR-Guided Procedures Package for the Open. Another Siemens user shares his clinical perspective on using the Open for routine MRI in an outpatient center. Two Siemens applications specialists offer articles on the technical considerations of low field imaging and optimized protocols for cervical spines and livers. An upcoming software upgrade, (B3.1), is announced for all MAGNETOM products. As usual, we announce upcoming educational seminars and meetings for your continuing education, and several applications tips and announcements to help you in your day-to-day practice. On the lighter side, one of our applications specialists asks the question "What, an interventional MR Tech?" in an editorial entitled "Whatever happened to clean MRI?"

All articles represent the techniques and opinions of the authors and may not represent specific recommendations or endorsements from Siemens Medical Systems, Inc. Contact the authors directly for further information about their techniques and opinions.

If you are within the United States, contact Gary McNeal (see below) to submit your contributions, to request previous issues, or to add your name to the mailing list (please, no home addresses). If you are outside the United States, contact Dagmar Thomsik-Schröpfer, Ph.D. (see below).

Gary R. McNeal, MS

THE MAGNETOM Flash

PUBLISHED BY:
MR Applications Group
Siemens Medical Systems, Inc.
186 Wood Avenue South
Iselin, NJ, 08830, USA

CORRESPONDENCE and
U.S. DISTRIBUTION:
Gary R. McNeal, MS
Editor, MAGNETOM Flash Newsletter
Siemens Medical Systems, Inc.
1108 Bradley Drive
Franklin, TN, 37069, USA
Phone 800-753-6336, 2112
Fax 615-591-7094

INTERNATIONAL DISTRIBUTION:
Dagmar Thomsik-Schröpfer, Ph.D.
MR Marketing Worldwide
Siemens Medical Engineering, AG
Henkestrasse 127
D-91052, Erlangen, Germany
Phone 49-9131-846181
Fax 49-9131-842186

TECHNICAL EDITOR:
Helmuth Schultze-Haakh, Ph.D.

B3.1A SOFTWARE UPGRADE:
ALL MAGNETOM PRODUCTS SHARE SAME PLATFORM

Finally, Siemens will upgrade all current MAGNETOM products (Open, Impact, Impact Expert, Vision) to share the same software platform. With the upcoming introduction of B3.1A software in the first quarter of 1997, all Siemens MR users will enjoy the same time-proven interface which includes such powerful features as Integrated Rectangular FOV, Phase and Partition Oversampling, Relative Signal-to-Noise Indicator, Pixel-size Indicator, Freely-selectable Presat Bands, Tracking Presat Bands, Click On/Off FatSat and MTS, Automatic MAPshim, Auto-Display, and DICOM3 compatibility (industry standard image exchange format). This article will describe the new features of B3.1 software for the MAGNETOM Open and Impact systems; the next issue will contain an article describing the new B3.1A features for the MAGNETOM Vision and Impact Expert systems.

MAGNETOM OPEN

B3.1A software will provide new TSE sequences for head and spine imaging (Figure 1), a TrueFisp sequence for fast T2-weighted imaging (Figure 2), GMR sequences for interventional MR-Guided procedures, and a new CP Spine Coil.

MAGNETOM IMPACT

B3.1A software will support two new coils—a CP Neck Coil for cervical spine imaging and a 4 cm LP Loop Coil for imaging very small parts such as fingers and toes (15 mT/m only).

New advanced techniques for 15 mT/m systems will include 3D Multislab MRA for heads and necks, True Inversion Recovery for improved T1 contrast in pediatric heads (Figure 3), Echo Planar for ultrafast heavily T2-weighted imaging of uncooperative patients (Figure 4), Fat and Water Nulling for imaging silicone breast implants (Figure 5), and Turbo Spin Echo with 240 echoes for ultrafast cholangiography, urography, and myelography (Figure 6).

Figure 1: TSE sequences for head and spine imaging.

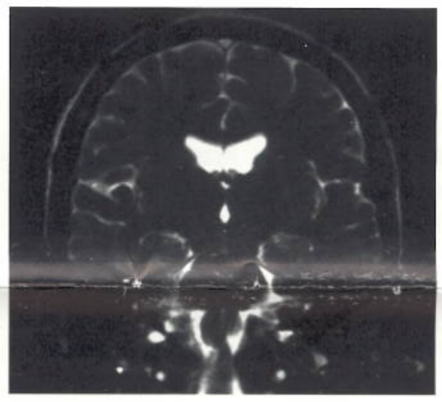

Figure 2: TrueFisp sequence for fast T2-weighted imaging.

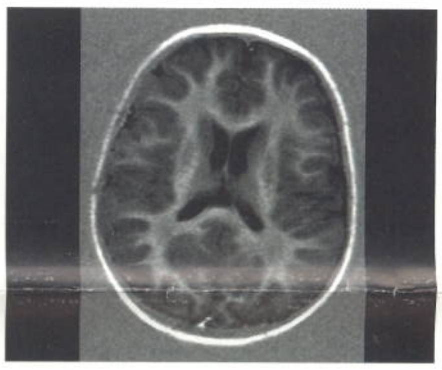

Figure 3: True Inversion Recovery for improved T1 contrast in pediatric heads.

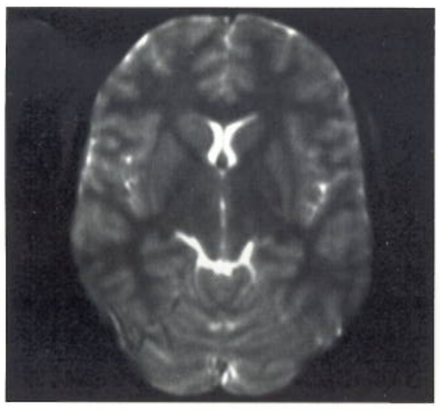

Figure 4: Echo Planar for ultrafast heavily T2-weighted imaging of uncooperative patients.

Figure 5: Fat and Water Nulling for imaging silicone breast implants.

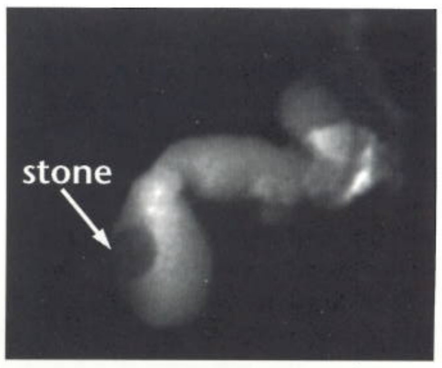

Figure 6: Turbo Spin Echo with 240 echoes for ultrafast cholangiography, urography, and myelography.

CONTINUING EDUCATION:
SEMINARS AND MEETINGS

For additional information or to include a meeting announcement in a future issue of the FLASH, contact Michele McDonald, MR Applications Coordinator (phone 908-321-3270, fax 908-321-3219).

Oct 20-25, 1996	Neuro-Orthopedic Review, MRI Education Foundation, Inc., Cincinnati, OH
Oct 24-27, 1996	11th National Symposium, Economics of Diagnostic Imaging, Sheraton Washington Hotel, Washington, DC
Nov 27-29, 1996	MRI Orthopedic Workshop, MRI Education Foundation, Inc., Chicago, IL
Dec 1-5, 1996	Radiological Society of North America (RSNA), Chicago, IL
Jan 21-26, 1997	International MRI Meeting, Garmisch-Partenkirchen, Germany
Feb 1, 1997	Northwest Regional SMRT Seminar, Evergreen Hospital Medical Center, Kirkland, WA
Feb 13-17, 1997	Annual Meeting of American Association of Orthopedic Surgeons, San Francisco, CA
Feb 19-21, 1997	Fourth Annual MRI Conference for Technologists, Northwest Imaging Forums, Luxor Hotel and Casino, Las Vegas, NV
Mar 2-7, 1997	Snowmass 1997: MRI in Clinical Practice, Educational Symposia, Inc., Snowmass, CO
Mar 3-7, 1997	European Congress of Radiology, Vienna, Austria
Apr 12-18, 1997	Fifth Scientific Meeting and Exhibition of the International Society for Magnetic Resonance In Medicine, Vancouver, BC, Canada

CLINICAL ARTICLE:
A CLINICAL PERSPECTIVE ON OPEN MR IMAGING

Don Wilson, R.T., Manager, York Imaging Center, York, PA
E-mail: mrimra@cyberia.com

Apples and oranges, high field and low field—we like them both, for different reasons. We have a 1.5T MAGNETOM system and a 0.2T MAGNETOM Open system. Our 1.5T has been used for years, and we built our referrals on the merits of 1.5T image quality. However, the changing health care scene has influenced our practice, along with our perspective on low field imaging. It's no longer high field versus low field. Now it's the benefits of having both high field and low field under one roof.

DECLINE IN REFERRALS

We experienced a decline in referrals starting in 1992. Governmental changes, managed care, and a doubling of MRI systems in our area all impacted our referrals. We examined our MR service to determine what we could do to expand referrals (Figure 1).

One population segment that came to our attention was the claustrophobic patient. Even with medication, we lost 2.4% of our patients to claustrophobia with our high field unit. A survey indicated that 15% of patients thought they were claustrophobic. Obviously, many claustrophobics never made it through our doors, and we realized that this presented an opportunity for expansion.

We also knew that we lost a few over-sized patients every week that were too big to fit into our high field bore, but there was no way to know how many of these patients we might be missing because we didn't get their referrals to begin with.

WHY WE CHOSE THE MAGNETOM OPEN

Other open architecture MR systems have been around for a long time. However, their low field strengths, weak gradient systems, and nominal coil and sequence performance typically produced low quality images. The MAGNETOM Open, on the other hand, already shared many high field Siemens features: 15 mT/m actively shielded (AS) gradients, SunSPARK host computer, NUMARIS user interface, and clinically optimized pulse sequences. The images from the MAGNETOM Open system were much better than we had anticipated. While this system is only 0.2T field strength, the scan times were equal or shorter than those of the 0.5T system we had many years before.

THE CLAUSTROPHOBIC PATIENT

The MAGNETOM Open appeared to be our answer for helping the claustrophobic patient. We started using our MAGNETOM Open in August of 1995 and, initially, we only marketed the open aspects of the product, especially patient comfort. A survey of patients scanned on our MAGNETOM Open revealed that 58% were referred because they indicated they were claustrophobic. We are seeing many first time MR patients who would not even have considered an exam in a conventional MR system. This leads me to believe that our 15% claustrophobia finding on earlier patient surveys was low because we were totally missing a segment of the population.

The claustrophobic patient was the first to embrace this truly open architecture system. We allow friends and relatives to accompany a patient in the scan room after appropriate safety screening. Often we will pull a chair up alongside the magnet and let the patient hold hands with their companion (Figure 2). Our use of medication has been reduced approximately in half.

The claustrophobic patient has a very high anxiety level approaching the MR scan for the first time. We spend a significantly greater time explaining the scan process and making these patients comfortable. We also utilize aroma therapy (cucumber oil) and find that this does help some patients. Another comforting aspect of the MAGNETOM Open system is that patients feel they can get out of the system should something go wrong.

We still occasionally lose a patient to claustrophobia. These claustrophobic patients need to be heavily sedated and can't even tolerate a CT scanner.

THE OVER-SIZED PATIENT

Although only 8% of the patients admitted to being referred because they were over-sized for the conventional system, we feel that the truth is closer to 25% of all referred patients. Wide hips, broad shoulders, big bellies and weight over 300 pounds are all factors which can prohibit a scan on conventional bore systems. We find this group of patients to be highly motivated to get the scan done. They frequently have been unable to have an MR exam or even alternative studies due to size and weight limitations. While the image quality may not be as good as with normal-sized patients, we almost always get a diagnostic study.

We have the new optional Patient Auxiliary Table (PAT) and the MP 45 cm flex coil for imaging the larger patients. The PAT provides 3 cm additional clearance from front to back and 12 cm additional table width. This extra wide table surface allows extra tissue someplace to go. If we can get the very large flex coil around the anatomy to be examined, we can get a reasonable study. These patients know the difficulty of being scanned and will let us stuff them into the system because they still feel they can get out. In most situations the patient's head and feet are outside the scanner and they can also reach and see outside.

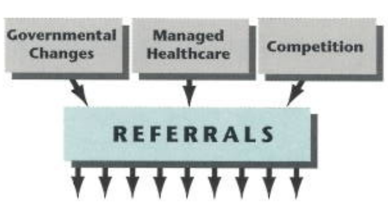

Figure 1: Three forces causing decreasing referrals are governmental changes, managed healthcare, and competition.

The coils for the MAGNETOM Open system have a much larger scanning field than similar coils on a high field system. An active imagination is the key to success with the use of coils and positioning of patients with the Open system. We have been successful with patients weighing up to 440 pounds. We have used body coils and the MP 45 cm flex coil to do cervical spines on patients who were very large and had no neck. We have been successful using coils on the Open that we would never consider using with a high field system. Except for the occasional extremely large patient, we now scan the over-sized patient population with reasonable success.

OTHER PATIENT POPULATIONS

The remainder of the referrals are those people who just plain prefer to be in an open system. A nearby hospital did a survey and found that elderly patients would much prefer an open system over a conventional system.

The vertical field and the solenoid type of coils also gives us a flexibility that we do not enjoy on the high field systems. We can scan a lumbar spine patient lying on his side or stomach without detriment to the image quality (Figure 3). We continue to lose an occasional patient on the high field system because he cannot lie on his back.

OPERATING COSTS

We have had a unique opportunity to isolate the costs associated with the operation of the resistive magnet of the MAGNETOM Open system. We replaced our superconducting 1.0T MAGNETOM 42SP system with a resistive 0.2T MAGNETOM Open system in August of 1995. We knew that, while the costs of cryogens would be eliminated, we would incur additional electrical costs; we wanted to know what these additional costs would be.

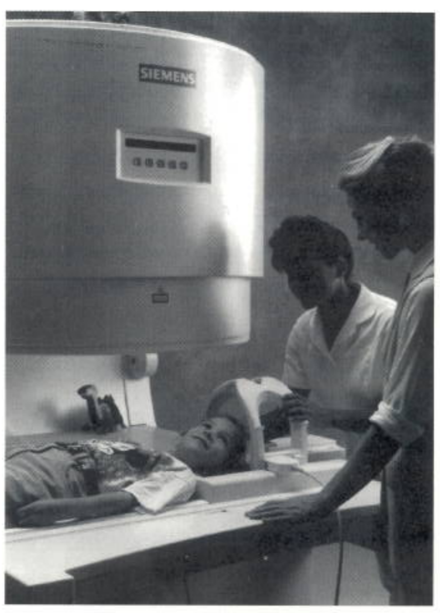

Figure 2: Open architecture allows medical staff and family members to remain in close contact with the patient during the scan.

We made a comparison of six months of billings after the Open was in operation. The workload had stabilized to an average of 14 exams per day. The system was operational for 14 hours per day, five days per week, essentially unchanged from the 42SP. The lighting, air conditioning and heating load was unchanged from the previous operation. The comparison covered both winter and summer months.

The average additional electrical costs were $600 per month, or $7200 per year. Since cryogens would normally run $35,000 per year for a superconducting magnet, the $7,200 per year in additional electrical costs actually represented a considerable net savings in operating costs. This works out to about $2.00 savings per patient.

MARKETING THE OPEN

We took a two-pronged approach to market our new capability—we did direct mailing campaigns to referring physicians and we went to the public with images of the MAGNETOM Open. Patients were prompted to "Ask Your Doctor" in our ad campaign. The patients have been an asset in getting the referring doctors to learn about the MAGNETOM Open system. The referring doctors are quite happy to get an MRI on a patient who was previously unable or unwilling to have a scan done on a conventional system.

The MAGNETOM Open system, along with an aggressive marketing program has restored referrals that had eroded over the past few years due to circumstances beyond our control (Figure 4).

Our perspective on open MRI is now quite different. While we were very concerned about the referrals getting shifted from the 1.5T system to the 0.2T Open, this wasn't the case. The 1.5T referrals have stayed consistent, with no significant change that we can determine. Apples and oranges, high field and low field—we like them both, for different reasons.

Figure 3: Lumbar spine patient lying on his side on the Patient Auxiliary Table while being imaged with the Large 45 cm Multi-purpose coil.

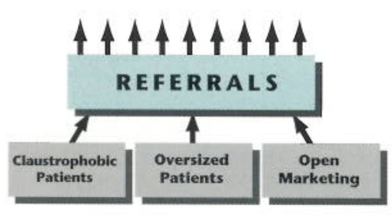

Figure 4: Three forces causing increasing referrals are claustrophobic patients, oversized patients, and MAGNETOM Open marketing.

TECHNICAL ARTICLE: PRINCIPLES OF LOW FIELD MR IMAGING

Helmuth Schultze-Haakh, Ph.D., MR Applications Scientist

Siemens Medical Systems, Tustin, CA

In recent years there has been an increased interest in low field MR Imaging—40 % of all MR systems sold this year were low field. There are a number of reasons for the success of such systems: lower purchasing and maintenance costs, improved magnet and gradient designs, reduced siting requirements, improved patient comfort and cooperation, as well as new and optimized applications.

ECONOMICS

In the process of evaluating the health-care situation, especially in the US, many hospital administrators are cautious in spending a lot of money for high end systems for fear that patient reimbursement might be limited and patients might not be as easily available as in the past. This might prevent the hospital from reaching the break-even point in a reasonable time. One has to look carefully into such investments and evaluate the price/performance ratio of every medical system. Advances in technology, magnet design and computer equipment have increased the value of MRI systems compared to a few years ago. Due to continual improvements in equipment performance the technical staff, radiologists, and referring physicians all have higher expectations of the technology. Also, MRI equipment has found its way into almost every radiology department, whether in-house, independent diagnostic centers or serviced by a mobile unit. The modality is widely accepted and is often the modality of choice rather than an alternative. It is for these factors that economical MR scanners are available to cover most of the daily "bread and butter" routine in radiology departments.

Specifically, the 0.2 Tesla MAGNETOM Open system is easily operated by a single technologist because all the optimized protocols and key post-processing features are fully integrated into the single console operating interface. Furthermore, the Open is more quickly and easily installed than most high field systems, and requires much lower operating costs. The break-even point is much easier to reach in a shorter time.

MAGNET DESIGN

Most low field MRI systems use either a resistive magnet or a permanent magnet. In either case, the costly cryogens used in superconductive magnets are avoided. A resistive magnet with a relatively low power consumption is used with the MAGNETOM Open system. The resistive magnet of the Open can be turned off when not needed for scanning, thus saving power and further reducing the operating costs. An added advantage in turning off the resistive magnetic is that emergency personnel and emergency equipment can safely be brought to the patient while still on the table.

There are various configurations for low field magnets—the traditional tunnel-shaped bore design, the open bore design with two opposing magnetic platforms separated by columns, or the open bore design of the MAGNETOM Open with a C-shaped magnet. Siemens has chosen the latter design for easier patient access from almost any approach to the table, making it easier for routine work as well as in emergencies. Modern magnet technology also provides much improved homogeneity as compared to a few years ago—the Open boasts only 5 ppm over a 400 mm spherical volume. With automatic shimming of the magnetic field to each patient and the virtual elimination of eddy currents, the image quality approaches that of many high field systems.

The flexible table movement of the MAGNETOM Open allows the anatomy of interest to be positioned right at the magnetic isocenter, thus reducing the need for off-center shifted imaging. The big advantage is that the magnetic field, the RF field, and the gradient fields are much more homogeneous at the isocenter, which leads to improved image quality.

SITING REQUIREMENTS

The need to build costly additions or deal with special siting restrictions is often encountered when installing high field systems. Since the fringe fields of the low field MAGNETOM Open system are significantly more confined than those of high field systems, this scanner can often be installed in the space allowed for traditional CT siting. The MAGNETOM Open system confines the 5 Gauss fringe field (pacemaker line) to within only about 2½ meters of the isocenter, the magnet is only about 1½ x 2 x 2 meters in size, and it weighs only about 12,000 kilograms. The electronics cabinet is less than 2 x 1 x 2 meters in size, and it weighs only about 1,500 kilograms.

PATIENT COMFORT AND COOPERATION

An important issue when purchasing an MRI system is the comfort, and thus the cooperation, of the patient during the scan. Pediatric patients can be more readily observed and family members can remain immediately close—even right next to the child. The spacier, brighter environment will also help reduce the occurrence of claustrophobia among patients. Due to the reduced RF heat deposition with low field systems, patient overheating is not a concern. In general, patient comfort increases cooperation, which increases image quality, which improves the diagnosis, which increases referrals, which increases revenue.

TECHNICAL CONSIDERATIONS

T1 Relaxation Times

As seen in the table below, T1 values of most tissues are about 40% lower on the 0.2 Tesla Open system (compared to 1.0 Tesla). However, fat is reduced by only 25%. Thus, fat is not quite as bright relative to other tissues on a 0.2 Tesla T1-weighted image (compared to 1.0 Tesla). The lower T1 values at lower field strengths cause an increased T1 spread at shorter repetition times (TR). Thus, for comparable T1 contrast, low field images require shorter TR's than high field images. However, when attempting to use shorter TR's, the anatomical coverage may be compromised and this may require additional scans or concatenation. Optimizing the excitation flip angle for a specific tissue and a specific TR can often improve the T1 contrast while providing sufficient coverage. Also note that, due to the lower T1 values, the inversion time (TI) for maximal fat nulling for short tau inversion recovery (STIR) sequences occurs at about 90 milliseconds on the 0.2 Tesla MAGNETOM Open system.

Sequence Bandwidth And Chemical Shift

It is well known that reducing the sequence bandwidth will also reduce the noise level of the acquisition, thus increasing the Signal-to-Noise Ratio (SNR). For example, reducing the bandwidth by one-half will increase the SNR by over 40%. But as bandwidth is reduced, the superimposed images of fat and water are slightly shifted apart by a few pixels (chemical shift artifact). The extent of this shift depends not only upon the sequence bandwidth, but also upon the slight difference in the Larmor frequencies of fat and water and upon the field strength of the MR system. Fat and water resonate at a difference of about 220 Hz at 1.5 Tesla, about 147 Hz at 1.0 Tesla, or about 29 Hz at 0.2 Tesla. The table below indicates the actual pixel shift and the relative SNR at various fields strengths and various bandwidths (Relative SNR is normalized to a value of 1.0 for a bandwidth of 78 Hz/pixel). Note that at typical bandwidths used for high field imaging (56-130 Hz/pixel), the chemical shift artifacts are easily observed (1.7-3.9 pixels). However, at typical bandwidths used for low field imaging (20-56 Hz/pixel), the chemical shift artifacts are barely observed or not at all (0.5-1.4 pixels).

Phase Cycling

The chemical shift between fat and water is 3.5 ppm, regardless of field strength. But, since different field strengths have different resonant frequencies, this translates into a chemical shift of about 220 Hz at 1.5 Tesla, about 147 Hz at 1.0 Tesla, or about 29 Hz at 0.2 Tesla. Thus, fat and water cycle in- and out-of-phase with a predictable cycle time that depends upon the field strength. The phase cycling time is the reciprocal of the chemical shift—about 4.5 milliseconds at 1.5 Tesla, about 6.8 milliseconds at 1.0 Tesla, or about 34 milliseconds at 0.2 Tesla. At 0.2 Tesla, fat and water are in-phase every 34 milliseconds (0 ms, 34 ms, 68 ms, 102 ms, ...) and out-of-phase (opposed-phase) half way between each in-phase point (17 ms, 51 ms, 85 ms, 119 ms, ...) In other words, fat and water switch from in-phase to opposed-phase every 17 ms.

The first in-phase condition always occurs at time=0, although it is

T1 Relaxation Times in Milliseconds

Tissue	1.5T	1.0T	0.2T	Rel. Difference (1.0T - 0.2T)
Fat	260	240	181	-25%
Muscle	863	730	370	-49%
Grey BM	917	809	492	-39%
White BM	783	680	388	-43%
Liver	490	430	228	-46%
Spleen	778	680	398	-41%

Bandwidth and Chemical Shift

Bandwidth (Hz/pixel)	Rel. SNR	Pixel Shift @ 1.5 Tesla	Pixel Shift @ 1.0 Tesla	Pixel Shift @ 0.2 Tesla
130	0.77	1.7	1.1	0.2
78	1.00	2.8	1.9	0.4
56	1.18	3.9	2.6	0.5
30	1.61	7.3	4.9	1.0
20	1.97	11.0	7.4	1.4
16	2.20	13.7	9.2	1.8

impossible to achieve TE=0 in an MR pulse sequence. Also, the actual field strength of many systems may be slightly different than the nominal field strength, which will slightly alter the actual cycle times.

Signal-To-Noise Ratio (SNR)

When imaging with a lower magnetic field strength, fewer protons contribute to the MR signal. This inherent limitation in signal, primarily seen on thin slices with small Fields-of-View (FOV), is often compensated by using additional signal averages (Acquisitions). This is the reason why imaging times are typically longer on low field systems as compared to high field systems. With the MAGNETOM Open, however, other factors such as sequence bandwidth and surface coil design have improved the SNR to the extent that the imaging times are not significantly longer as compared to high field systems.

ADVANCED TECHNIQUES

The MAGNETOM Open offers advanced techniques such as MR Angiography (MRA), Turbo Spin Echo (TSE), and Gradient Echo (2D and 3D). Additionally, it provides many high field applications which are not available on many other low field systems, such as FLAIR (Fluid Attenuated Inversion Recovery), DESS (Dual Echo in Steady State), MTS (Magnetization Transfer Suppression), Shared Echo TSE, RecFOV, and Phase Oversampling. Thin slices, commonly acquired on high field systems, are not only obtained with traditional 2D acquisition techniques on the Open but can also be acquired using 3D contiguous slice techniques. Traditional spin-echo sequences can be substituted with faster gradient echo sequences (FLASH) for good T1-weighting due to the inherently low susceptibility sensitivity of low field MRI systems. T2* decay much more closely resembles the true T2 decay on low field systems, making such substitutions possible.

Phase Cycling in Milliseconds

Field (T)	Freq (MHz)	Shift (Hz)	Cycle (ms)	In-Phase TE's (ms)	Opposed-Phase TE's (ms)
0.2	8.4	29	34	0, 34, 68, 102, ...	17, 51, 85, 119, ...
1.0	42	147	6.8	0, 6.8, 13.6, 20.4, ...	3.4, 10.2, 17.0, 23.8, ...
1.5	63	220	4.5	0, 4.5, 9.0, 13.5, ...	2.3, 6.8, 11.3, 15.8, ...

CASE REPORT:

RECURRENT SQUAMOUS CELL CARCINOMA OF THE OROPHARYNX

Jonathan S. Lewin, M.D. and Mark E. Clampitt, R.T. (R), Department of Radiology

University Hospitals of Cleveland / Case Western Reserve University, Cleveland, OH

HISTORY

The patient is a 55-year-old gentleman who initially presented six years ago with a right neck mass. On neck dissection, the mass was determined to represent squamous cell carcinoma, but the primary site was unknown. Three years later, he developed difficulty swallowing and was found to have a base of tongue tumor, which was treated with partial resection of the tongue, laryngectomy and radiation therapy. The patient now presented with oropharyngeal ulceration and near-fatal bleeding, requiring treatment with endovascular coils. A CT scan demonstrated poor definition of tissues, although it was not possible to distinguish between radiation or postsurgical changes and recurrent tumor. The patient was then referred for an MR examination of the neck.

MR IMAGING FINDINGS AND PROCEDURE

On MR imaging, there was complete loss of soft tissue planes in the right side of the neck. There were two areas of intermediate signal intensity on T2-weighted images that were suspicious for tumor, one immediately adjacent to the right internal carotid artery and the second within the right tonsillar fossa. Due to the patient's near-fatal oropharyngeal hemorrhage, the treating surgeon was hesitant to perform a deep biopsy through the oral cavity, and the patient was referred for an MR-guided biopsy. Using a rapid 2D gradient echo sequence (FISP2D) and the in-room monitor for MR-"fluoroscopic" guidance, a 22 gauge aspiration needle was placed from a right lateral approach (Figure 1). The high vascular conspicuity afforded by in-flow effects with the 2D gradient echo sequence allowed precise localization of the internal carotid artery, which ran immediately adjacent and through the mass selected for biopsy. Prior to tissue sampling, the needle tip position was confirmed with a Turbo-Spin-Echo (TSE) proton density weighted image (Reference 1). The cytological results from the aspiration were nondiagnostic, and the oropharyngeal lesion was sampled under MR guidance using a slightly more posterior approach. Following fine needle aspiration, a core biopsy was performed using an 18 gauge E-Z-Em Biogun. Again, TSE higher resolution images were used to confirm the placement of the needle and location of the cutting gap (Figure 2) following MR-"fluoroscopic" guidance for needle placement. Although the fine needle aspiration was again nondiagnostic, the core biopsy demonstrated dense fibrous tissue with scattered malignant cells, suggesting recurrent carcinoma in the midst of dense radiation changes.

DISCUSSION

There were several advantages of MR for guidance of aspiration and biopsy in this patient. The major benefit stemmed from the excellent tissue contrast characteristics, demonstrating two areas more suspicious for tumor within widespread abnormalities throughout the right side of the neck. These areas could not be distinguished as different from surrounding radiation changes on the CT scan, and a CT-guided biopsy would have been a relatively "blind" procedure. The second major advantage of MR-guidance was the high vascular conspicuity afforded by the gradient echo MR-"fluoroscopic" pulse sequence. This allowed sampling very near the carotid artery, without significant risk of arterial injury. In addition to this rapid method, in which needle placement was performed during continuously updated images at a frame rate of slightly less than 2 seconds/image, the needle tip could be precisely located using a higher resolution TSE sequence (Reference 1). This is particularly important when larger cutting needle biopsy is performed, to accurately delineate the position of the cutting gap prior to obtaining the tissue sample (Figure 2).

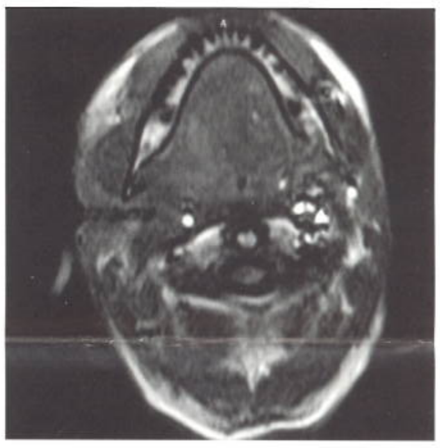

Figure 1: Using a rapid gradient echo (FISP2D) sequence and the in-room monitor for MR-"fluoroscopic" guidance, a 22 gauge aspiration needle was placed from a right lateral approach).

Figure 2: TSE higher resolution images were used to confirm the placement of the biopsy needle and location of the cutting gap.

Reference 1—Lewin JS, Duerk JL, Jain VR, Petersilge CA, Chao CP, Haaga JR. Needle Localization in MR-guided Intervention: Effect of Field Strength, Sequence Design, and Magnetic Field Orientation. American Journal of Roentgenology 166:1337-1345, 1996.

APPLICATIONS TIP:

MAGNETOM IMPACT EXPERT 3D MRA SEQUENCES

In software version B2.1E for the MAGNETOM Impact Expert there are four Multi-slab 3D MRA pulse sequences that contain small errors which may adversely affect image quality under certain conditions. When used with Phase Oversampling, these sequences contain image reconstruction errors which may cause digital pixel blow-out (value of 4095) or a "salt and pepper" appearance in entire sections of some images, particularly those images acquired in the overlapping regions between slabs. This can easily be determined by doing a MIP of the dataset in a direction perpendicular to the orientation of acquisition. This sequence error will be resolved in the next software version B3.1A to be released early in 1997. In the meantime, Siemens recommends avoiding the use of Phase Oversampling when doing Multi-slab 3D MRA with these sequences.

AFFECTED SEQUENCES

Fi3d_s_10rb108.wfc

Fi3d_s_tuf_10rb108.wfc

Fi3d_s_tun_10rb108.wfc

Fi3d_s_tun_10rb81.wfc

CLINICAL ARTICLE:
OPTIMIZED PROTOCOLS FOR CERVICAL SPINES AND LIVERS ON THE MAGNETOM OPEN

Helmuth Schultze-Haakh, Ph.D.
MR Applications Scientist
Siemens Medical Systems, Tustin, CA

Jay Rocker, M.S., R.T. (R)(MR)
MR Applications Specialist
Siemens Medical Systems, Minneapolis, MN

The following protocols have been optimized for routine imaging of the cervical spine and the liver with the MAGNETOM Open with B2.1B software. Future software revisions may allow even further improvements in these techniques.

CERVICAL SPINE

The 16 cm Shaped coil, the 21 cm Shaped coil, or the Large Multi-Purpose coil may be used for cervical spine imaging. It is essential that the parameters are not altered to any extent in order to assure consistent image quality from system to system. Be certain to keep the TR in the correct T1 range for low field imaging. That is, do not allow it to exceed about 520 ms. In order to keep imaging times down and to provide for adequate coverage of axial slices, the protocols in the axial orientation are designed to be run twice. You will notice the distance factor (DF) is 1.4. When done correctly, the two separate measurements will provide images with a net DF of 0.2. To do this, position your first axial measurement, with an odd number of slices, on a sagittal scout to achieve the desired coverage. Use a coronal image for the second localizer to observe the action of the rectangular field of view (RecFOV) to ensure there will be no wrap artifacts. Begin the measurement and notice the slice shift position. Reduce the number of slices by one (ie. if the first measurement had 9 slices, reduce this number to 8). Notice that the slice shift position changes when the slices are changed to an even number. Replace this newly changed slice shift with the original slice shift of the first measurement and begin (or queue) the second measurement. When both measurements are completed, you can combine the two image sets for ease of filming by using either Study/ Arrange/ Combine/ Query or by using Study/ Create. Utilize this procedure for both the se_t1_axial and the fl_t2_axial protocols.

Figure 1: Spin Echo T1-weighted Sagittal Cervical Spine.

Figure 2: Turbo Spin Echo T2-weighted Sagittal Cervical Spine.

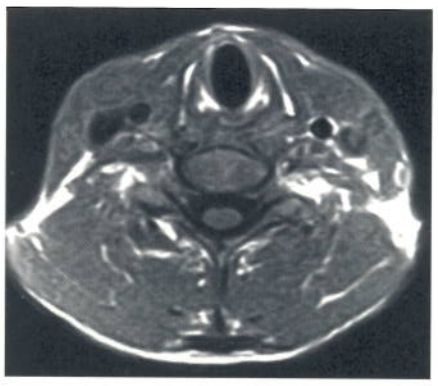

Figure 3: Spin Echo T1-weighted Axial Cervical Spine.

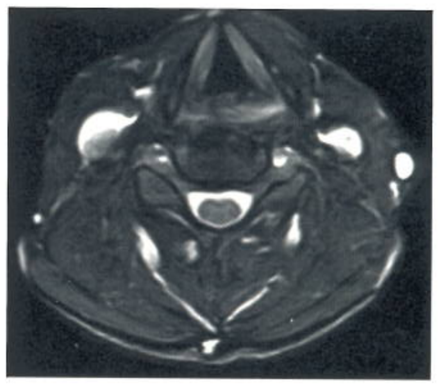

Figure 4: FLASH2D T2-weighted Axial Cervical Spine.*

Proto:	se_t1_sagittal	tse_t2_sagittal	se_t1_axial	fl_t2_axial
Time:	5:17 min	6:01 min	5:10 min	5:53 min
Sequ:	se_26b39.uhc	tse7_114rrb65.uhc	se_15b78.uhc	fl2d_46rb20.uhc
TR:	510 ms	4000 ms	400 ms	780 ms
TE:	26 ms	114 ms	15 ms	46 ms
TI:	0 ms	0 ms	0 ms	0 ms
Flip:	90 deg	180 deg	90 deg	40 deg
Acq:	4	2	4	2
Meas:	1	1	1	1
Number:	9	9	11	9
Thick:	4 mm	4 mm	4 mm	4 mm
Dist:	0.2	0.2	1.4	1.4
FOV	250 mm	250 mm	220 mm	220 mm
RecFOV:	6/8	6/8	8/8	8/8
Matrix:	154 x 256,o	154 x 256, o	192 x 256, o	225 x 256,o
Phase OS:	0 %	0 %	0 %	0 %
FatSat:	no	no	no	no
MT:	no	no	no	no
Swap:	no	no	yes	yes
Half Four:	no	no	no	no
Phase Img:	no	no	no	no
Trigger:	no	no	no	no
Interpol:	no	no	no	no
Inline adj:	yes	yes	yes	yes
Shim adj:	no	no	no	no
Excit Ord:	interleaved	interleaved	interleaved	interleaved
Filter:	hanning (W)	hanning (W)	hanning (W)	hanning (W)
Presats:	1 cor 80 mm	1 cor 80 mm	no	no

BREATHHOLD LIVER

For imaging of liver lesions, there are two breath-hold protocols which can be used. Both the T1- and T2*-weighted protocols use gradient echo sequences to acquire a limited number of slices through a specific region of interest.

The T1-weighted protocol can actually acquire 9 slices if no presat bands are used, but vascular pulsation artifacts will be present. With the presat bands, the aorta and the IVC are black.

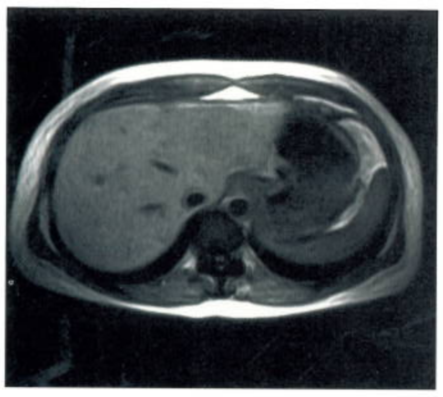

Figure 5: FLASH2D T1-weighted Axial Breath-hold Liver.

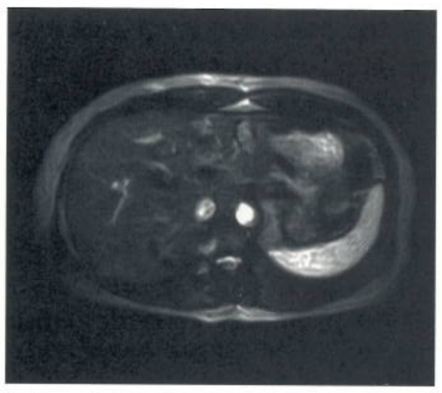

Figure 6: FLASH2D T2-weighted Axial Breath-hold Liver.*

Proto:	fl_t1_axial_bh	fl_t2_axial_bh
Time:	21 sec	27 sec
Sequ:	fl2d_9b78.uhc	fl2d_46rb20.uhc
TR:	198 ms	260 ms
TE:	9 ms	46 ms
TI:	0 ms	0 ms
Flip:	90 deg	30 deg
Acq:	1	1
Meas:	1	1
Number:	3	3
Thick:	8 mm	8 mm
Dist:	0.25	0.25
FOV	350 mm	350 mm
RecFOV:	6/8	5/8
Matrix:	96 x 256,o	100 x 256, o
Phase OS:	0 %	0 %
FatSat:	no	no
MT:	no	no
Swap:	no	no
Half Four:	no	no
Phase Img:	no	no
Trigger:	no	no
Interpol:	no	no
Inline adj:	yes	yes
Shim adj:	no	no
Excit Ord:	ascending	ascending
Filter:	hanning (W)	hanning (W)
Presats:	2 parallel	no

ON THE LIGHTER SIDE:
WHATEVER HAPPENED TO "CLEAN" MRI?

Jay Rocker, M.S., R.T. (R)(MR), MR Applications Specialist
Siemens Medical Systems, Minneapolis, MN

How many of you technologists entered the field of MRI simply because it was "clean"? There wasn't a lot of physical patient contact. No devices to plug into various parts of the patient. Nothing gross smelling or disgusting for the patient to drink. No IV's to start, no need to wear double gloves or protective glasses. Heck, you even looked forward to a complete day of no one telling you "I drank enough, you drink the rest!!"

Then came the introduction of gadolinium-based contrast agents to the market. But, oh well, we could manage. It didn't require a large injection, no big bolus. And, most importantly, it didn't make patients want to throw up. "Hey, this isn't so bad, is it?!" We could use a small butterfly needle and inject the 20 cc's or so, rather slowly. We adjusted, we survived.

Then came the introduction of various surface coils for high resolution imaging, some of which required insertion into the patient (i.e. for prostate imaging), and the introduction of MR-compatible equipment which could be used for anesthesia cases, ICU cases, emergency room cases, etc. "Clean" MRI was rapidly becoming a thing of the past.

Well folks, the "hands-on" imaging we tried to avoid by going into MRI may have caught up to us. This year, Siemens announced availability of an MR-Guided Procedures (MRGP) package to support diagnostic and therapeutic procedures using MR-compatible biopsy needles and catheters with the open-architecture MAGNETOM Open system (Figure 1). Using special sequences, the physician can now monitor the advancement of an MR-compatible needle into pathological processes (Figure 2).

"What, an Interventional MRI Tech?" Sure, why not?! Heck, we all live to be cross-trained, right?! Think of the possibilities for your MRI department. It's a way to expand instead of contract. And, think of the possibilities for your patient. MR-Guided Procedures can shorten the time from visualization of a lesion to therapy, minimize damage to good tissue, and shorten hospital stays. All in a radiation-free MR environment. The MAGNETOM Open offers another safety benefit, too: the physician and patient do not have to worry about long term exposure to the magnetic field—it's well within the OSHA standards.

The MRGP package has been used in clinical trials in Europe and the U.S. with very rewarding results. And with the open-architecture design of the MAGNETOM Open system, these MR-Guided procedures just naturally evolved out of a need for more efficient diagnostic imaging and treatment techniques.

In the U.S. to date, the use of the MRGP package with the MAGNETOM Open system has received FDA 510(k) pre-market clearance only for interventional tissue biopsies, drainages, fine needle aspirations, and procedures that require the injection of a therapeutic agent. All other MR-Guided interventional or surgical procedures are currently "investigational" in the U.S.

Figure 1: product photo of MRGP package.

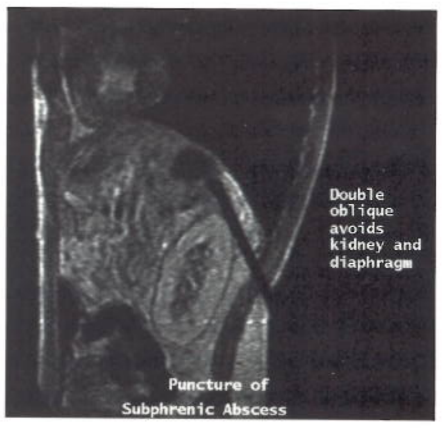

Figure 2: MR image of biopsy needle within pathological process.

APPLICATIONS TIP:
GOP IMAGE FILTER

Different types of images need different degrees of noise reduction and structural edge enhancement. Therefore a selection of smooth, medium or sharp can be set. In an early version of the GOP post-processing filter the smooth, medium and sharp settings were assigned values with the range 1-10. A high value (8-10) corresponds to a high degree of structural edge enhancement, a low value (1-3) corresponds to a high degree of noise reduction, and a mid-range value (4-7) corresponds to a combination of the two.

The current version of the GOP filter also incorporates another higher range of values from 11-20 which are recommended specifically for 512 matrix images (but can also be used for other image matrices as well). In general, this upper range of values (11-20) behaves similar to the lower range of values (1-10). A lower value (11-13) gives better noise reduction but also higher signal amplification as compared to a higher value (18-20).

Since your choice of the optimal image filter for any given exam is highly subjective, you may wish to experiment with various choices before deciding to change the default values.

In the current MAGNETOM Open software version B2.1B, the default values for the GOP filter are in the upper range (11-20). However, you may wish to change the smooth, medium, and high values to the lower range (1-10). Although there is no way to permanently change the Siemens defaults, there is a quick work around. Simply open the GOP platform, change the default values to those which you desire, and then "iconize" the platform rather then "exit" the platform when it is not being used. This will keep the changed values as long as the system is not shut down.

APPLICATIONS TIP:
MAGNETOM OPEN GRE SEQUENCES

In software version B2.1B for the MAGNETOM Open, there are six gradient echo pulse sequences that contain small errors which may adversely affect image quality under certain conditions. Although these sequences should compensate for minor variations in the magnetic field (which can routinely occur), the algorithms do not sufficiently compensate in all cases. As a result, they may produce three or four good images out of the entire stack. This sequence error will be resolved in the next software version B3.1A which is scheduled to be released early in 1997. In the meantime, Siemens recommends the use of alternative sequences.

AFFECTED SEQUENCES	ALTERNATIVE SEQUENCES
Fi3d_12b65.uhc	Fi3d_17b56.uhc
Fi3d_35rb30.uhc	none
FL3d_ns_9b56.uhc	FL3d_ns_8b56.uhc
FL3d_12b65.uhc	FL3d_17b56.uhc
FL3d_35rb30.uhc	none
FL2d_25b30.uhc	FL2d_23b24.uhc or FL2d_30rb30.uhc

ANNOUNCEMENT:
ULTRAFAST IMAGING VIDEO

Siemens has released a new video which explains the basic concepts and applications of a new generation of ultrafast MR Imaging pulse sequences (HASTE and EPI). A quiz is included which can earn MR technologists 0.5 hours of category A continuing education credits from the ASRT. In August 1996 Siemens sent this video to the Chief MRI Technologist at every U.S. site having either a MAGNETOM Vision or Impact Expert system. Additional copies of this video are available free-of-charge to all Siemens MR customers in the U.S. Contact your local Siemens MR Applications Specialist, MR Product Specialist, or the Siemens MR Applications Hotline (800-333-3137).

ANNOUNCEMENT:
ERROR CORRECTION

In the last issue of this Siemens MAGNETOM Flash Newsletter, Jonathan Lewin, M.D., was erroneously listed as a radiologist at the Cleveland Clinic (Volume 4, Number 3, July 1996, MAGNETOM USERS MEETING AT ISMRM). Actually, Dr. Lewin is the Director of MRI at University Hospitals of Cleveland / Case Western Reserve University in Cleveland, OH.

ANNOUNCEMENT:
NEW HOTLINE HOURS

For the past year Siemens has answered the MR Applications Hotline (800-333-3137) from 9:00am to 9:00pm (ET) in the US However, beginning October 1, 1996, the Hotline will be answered from 9:00am to 5:00pm (ET). We found that only a trickle of calls were coming in after 5:00pm.