SIEMENS

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The MAGNETOM Flash

Newsletter for Siemens MAGNETOM Users

IN THIS ISSUE...

From the Editor

The MAGNETOM Flash continues to report pertinent news to meet your professional needs. This issue is the first in a two-part series focussing on routine clinical MR angiographic techniques. This issue will address Time-of-Flight techniques used for body and peripheral MRA, whereas the following issue (Fall 1995) will address Phase Contrast techniques. We will begin a new column called "Ask The Experts" in which acknowledged experts in the field of MRA will answer questions that you, our users, commonly ask. You will also find a description of the complete upgrade path available to current Impact users. As always, this issue contains announcements about upcoming conferences, useful applications tips, and interesting case histories.

All clinical feature articles represent the techniques and opinions of the authors and may not represent specific recommendations or endorsements from Siemens Medical Systems, Inc. Authors sometimes describe results from their own "home-brewed" or modified sequences and post-processing programs developed by their own in-house scientists. Please feel free to contact them directly for further information about their unique techniques.

Since this is your newsletter, you are cordially invited and urged to contribute articles, images, announcements, interesting cases, questions, comments, etc. Remember, your "special technique" or your "unique insight" into a particular technical issue may be "big news" to other Siemens' users. So, please contact me by phone, fax, or mail to submit your contributions, to request previous issues, or to add your name to the mailing list for the MAGNETOM Flash (no personal home addresses, please).

Gary R. McNeal, Editor

THE MAGNETOM Flash

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ANNOUNCEMENT
MAGNETOM IMPACT EXPERT

Do you need help figuring out which options you need in order to get specific sequences and features? This chart should help guide you in determining the benefits of various upgrades.

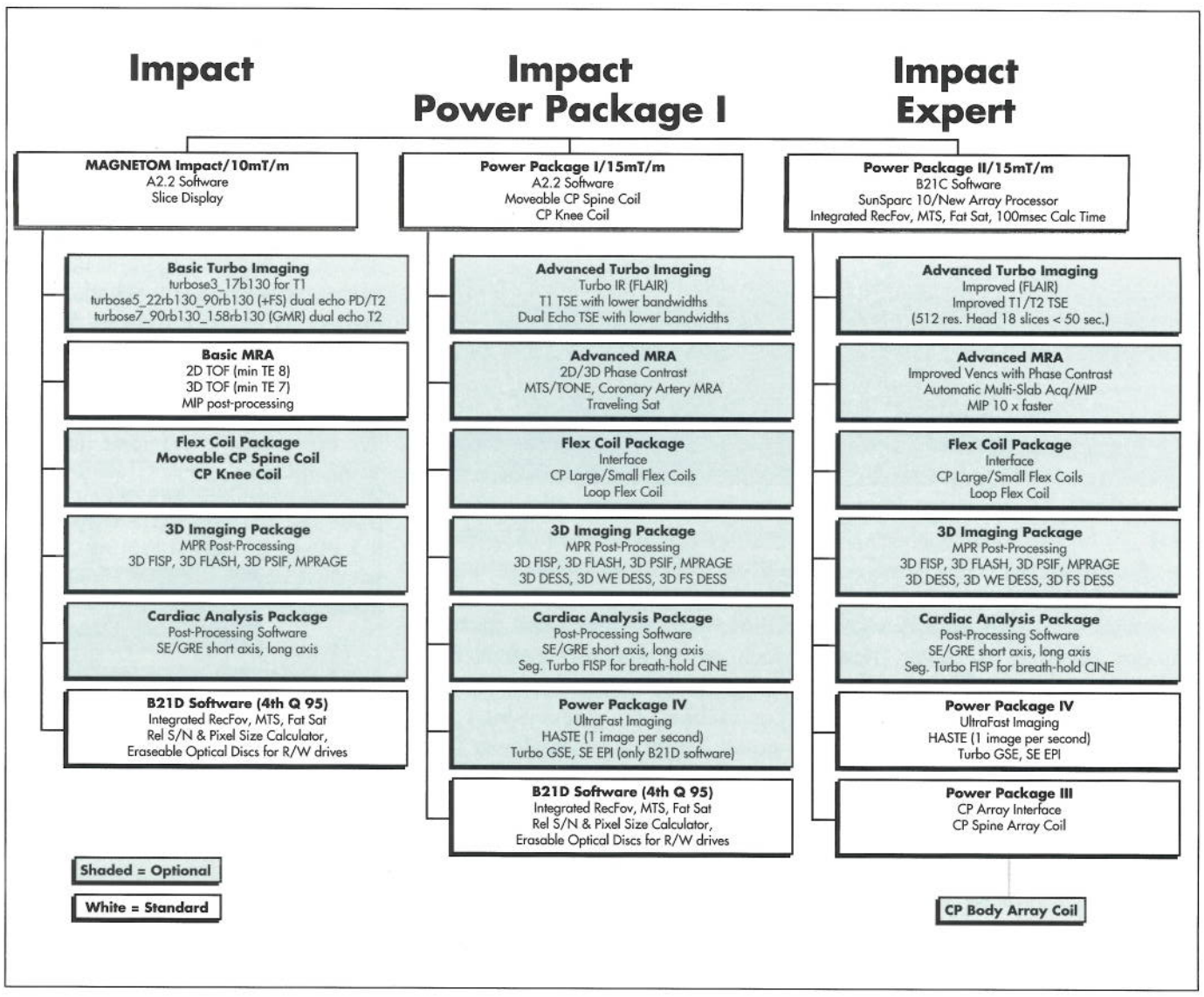
The **MAGNETOM Impact Expert** configuration is now available in the United States. It combines the best of the **Power Package** series to offer the best deal available today in a 1.0 Tesla system:

- **Power Package II** (SunSPARC 10, New SMI Array Processor, B21C Software)
- **CP Spine Array Coil** (CP Spine Array Coil, Interface)
- **Power Package IV** (Ultrafast Imaging Sequences HASTE and TGSE)
- **CP Flex Coil Package** (Small and Large CP Flex Coils, Loop Flex Coil, Interface)
- **Advanced Turbo Imaging** (TIR, FLAIR, Breathhold TSE, Lower Bandwidths)
- **Advanced MRA** (Phase Contrast, MTS/TONE, Travelling Sats, 3D Multislab)

The MAGNETOM Impact Expert has an attractive leasing program- please call 1 (800) 321-3287 if you are interested in leasing a new system.

MAGNETOM Impact Expert Upgrade

If you are interested in upgrading your MAGNETOM Impact to the Expert level, fill in the attached postcard or contact your local Siemens sales representative. Please note that the Flex Coils, Advanced TSE and Advanced MRA are not included in the upgrade, as many sites have already purchased these options. Those sites that upgrade to the MAGNETOM Impact Expert will, of course, keep any prepurchased options.



Seminars and Meetings

For additional information on any of these meetings, or to include a meeting announcement in our next issue of the FLASH, please contact Michele McDonald (MR Applications Group) at (908)321-3270 or fax (908)321-3219.

Aug 19, 95	MAGNETOM Users Meeting at the SMR, Plaza Hotel, Nice, France, 6-10 pm.
Aug 28-Sep 1, 95	MR Imaging: Concepts & Applications, Cary, NC.
Sep 6-10, 95	Advances in Mid & Low Field MRI, Buena Vista Palace, Orlando, FL.
Oct 9-11, 95	MRI Clinical State of the Art, New York University Med Ctr, New York City, NY.
Oct 9-13, 95	MR Imaging: Concepts & Applications, Cary, NC.
Nov 13-17, 95	MR Imaging: Concepts & Applications, Cary, NC.
Mar 8-11, 96	MRI Conference for Technologists, Pacific Northwest Forums, Dallas, TX.
Apr 96	Siemens Spring Technologists Seminar, date and location TBA.

TECHNICAL ARTICLE: Time-of-Flight MR Angio

Dennis Atkinson, M.S.
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Siemens Medical Systems, Iselin, NJ

Helmuth Schultze-Haakh, Ph.D.
Applications Scientist
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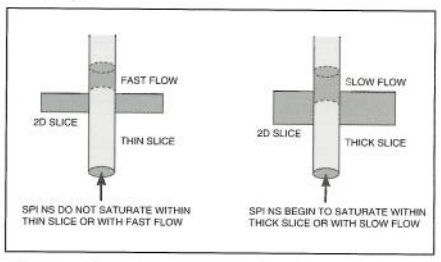
Time-of-flight magnetic resonance angiography (TOF MRA) is a compromise of three essential and interdependent factors: suppression of background signal, enhancement of flow signal, and production of good image quality (e.g., signal-to-noise ratio and resolution). Improvement in one factor is often at the expense of another. Compromises are often imposed by the patient, the operator and the MR imaging system.

The basic premise of TOF MRA is that for flowing spins there is increased longitudinal magnetization (Mz) and enhanced signal (Si) because of less saturation from exposure to radio-frequency pulses (RF) as compared to the stationary background spins. The simplest form of TOF MRA uses a 2D gradient echo pulse sequence with a thin slice, a short repetition time (TR), an optimal echo time (TE), a moderate to high flip angle (FLIP), and a flow compensation technique called gradient motion rephasing (GMR). The 2D TOF MRA method is often used for either a quick (breath-hold) visualization of fast flow or to improve the visualization of slow or pulsatile flow. The flow compensation technique (GMR) is essential to prevent signal loss due to spin dephasing.

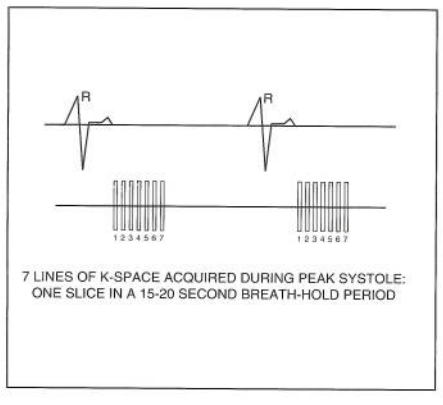
Combining a short TR (25-40 ms) and a moderate to high FLIP (30-60 deg) promotes excellent suppression of background signal because the stationary spins in the slice experience a fast train of high amplitude RF pulses, thus becoming RF "saturated". Imaging with the optimal TE to allow fat and water to be opposed in phase (10 ms @ 1.0 Tesla, or 7 ms @ 1.5 Tesla) further suppresses the unwanted fat (background) signal without affecting the water (flow) signal. Using a thin slice (2-5 mm) promotes excellent enhancement of flow signal because the spins pass very quickly through the slice and have little time to become RF "saturated". Using a thin slice also produces nicer MIP images. Using GMR also improves the enhancement of flow signal because the moving spins are not allowed to dephase, thus preventing signal voids and motion ghosting.

The optimal combination of TR, TE, FLIP, slice thickness and slice orientation for a given clinical situation depends strongly upon the speed and direction of the flow being imaged. With thin slices oriented perpendicular to the direction of flow, there is maximal flow signal enhancement due to rapid and complete replacement of fast flowing spins within the slice. These spins have a relatively short "time-of-flight" within each slice, thus minimizing RF saturation. Even the most frequent RF pulsing (shortest TR and shortest scan time) with a high FLIP (best background suppression) cannot saturate these flowing spins. However, for spins having a relatively long "time-of-flight" due to either slower flow or thicker slices or in-plane flow, there is less enhancement of flow signal due to incomplete replacement of spins within the slice. Thus, especially for slow flow, the best results are obtained by using the thinnest possible slices and orienting those slices strictly perpendicular to the direction of flow (e.g., axial slices for jugular veins).

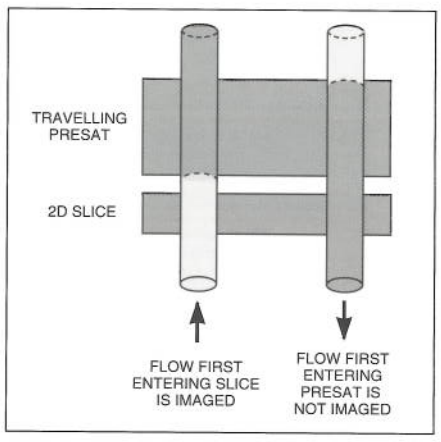


If we choose to use thicker slices or orient the slices such that flow remains within the slice plane for clinical reasons, such as coverage or viewing angle, we may need to compensate with less frequent RF pulsing (longer TR) and/or lower FLIP (less flow saturation but less background suppression). For example, when imaging the carotid arteries with transverse 2D slices it may be preferable to use a short TR (30 ms) and high FLIP (50 deg), but to prevent saturation of the superior segments when imaging the carotid arteries with coronal or sagittal 2D slices it may be preferable to use a longer TR (40 ms) and/or lower FLIP (35 deg).

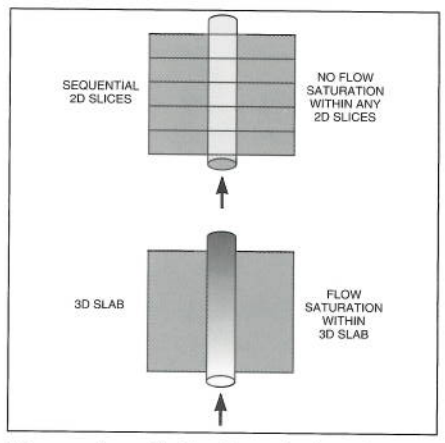
Finally, ghosting artifacts and flow voids due to highly pulsatile flow can be essentially eliminated by acquiring the echoes predominately during peak flow periods in the cardiac cycle (triggering to systole). However, specific flow patterns such as turbulence secondary to complex pathology (e.g., aortic coarctation or aneurysm) may require triggering to a slower flow period (diastole) to reduce flow voids from turbulent dephasing. Some 2D TOF sequences have been designed to acquire a single slice in a single breath-hold period while cardiac triggering, thus minimizing both respiratory and pulsatile artifacts. These segmented k-space sequences typically acquire 7-15 phase lines per heartbeat during a typical breath-hold period of 15-20 seconds. This technique is particularly effective for high quality imaging of thoracic and abdominal arteries.



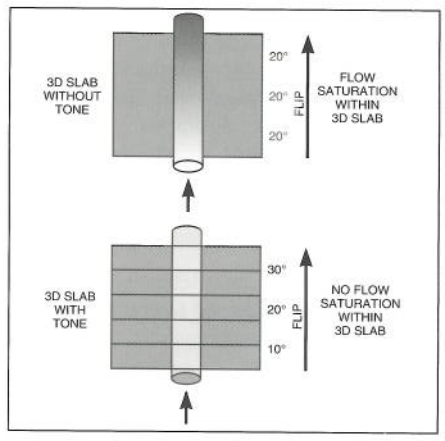
In order to keep the TR as short as possible for a multislice scan, an adaptation of the 2D pulse sequence has been designed to acquire the slices in a "sequential" fashion rather than "interleaving" them within an extended TR. Such "sequential" pulse sequences may be denoted with "_S_" within their name, e.g. FLASH2D_S_10RB195. All 2D TOF MRA techniques should use "sequential" pulse sequences with an ascending or descending slice series rather than an interleaved slice series. For body MRA techniques, a further adaptation of the 2D "sequential" pulse sequence has been designed with a built-in breath-hold period. Such sequences may be denoted with "_S_BH_" in their name, e.g., FLASH2D_S_BH_10RB108. In order to provide selective presaturation of either arterial or venous flow, a further adaptation of the 2D "sequential" pulse sequence has been designed with a built-in presaturation band right next to the slice that moves with the slice. Sequences containing these "travelling presats" may be denoted with "_SU_" (for upward flow, towards the head) or with "_SD_" (for downward flow, towards the feet) within the sequence name (e.g., FLASH2D_SU_9RB195). In the "_SU_" version, the "travelling presat" is superior to the transverse slice (regardless of whether the patient is registered head-first or feet-first), so upward flowing blood will be imaged while downward flowing blood will be suppressed. In the "_SD_" version, just the opposite is true.



From these same basic principles, 3D pulse sequences have been developed which perform TOF MRA of fast flow with even thinner effective slices (0.75 - 1.5 mm partitions) and higher SNR than 2D techniques. However, due to the much longer "time-of-flight" of spins through the thicker 3D slab, RF saturation becomes prohibitive for slow flow or for tortuous flow and can even be a big problem for fast flow. This problem may be minimized by the use of a relatively thin 3D slab (approximately 20-40 mm) but at the expense of coverage, and/or by slightly decreasing the FLIP (approximately 15-25 deg) but at the expense of less effective suppression of the stationary background tissue.



Recently, "tilted-optimized-non-saturating-excitation" (TONE) RF pulses have been added to some 3D sequences to reduce signal loss through the slab. These TONE pulses operate by varying the FLIP spatially through the 3D slab to minimize the saturation of the flowing spins as they traverse the slab, maintaining good signal uniformity throughout the slab. For a TONE pulse to be effective, the 3D slab must be correctly oriented with respect to the direction of flow. There are "TONE UP" sequences, denoted with "_TU_" in the sequence name. These are acquired in the transverse orientation to image flow toward the superior direction (carotids, internal cerebral arteries), regardless of whether the patient is registered head-first or feet-first. There are "TONE DOWN" sequences, denoted with "_TD_" in the sequence name. These are acquired in the transverse orientation to image flow toward the inferior direction (renal arteries). A big clinical advantage with TONE sequences is the improved visualization of small peripheral intracranial vessels that would otherwise be completely RF saturated.

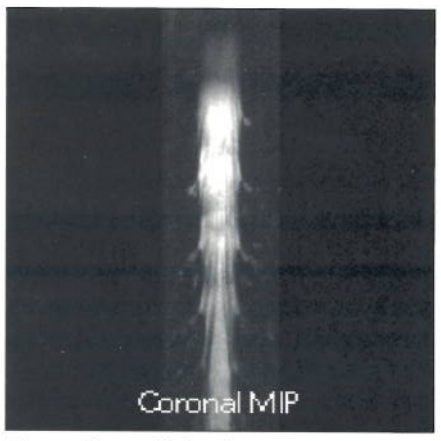


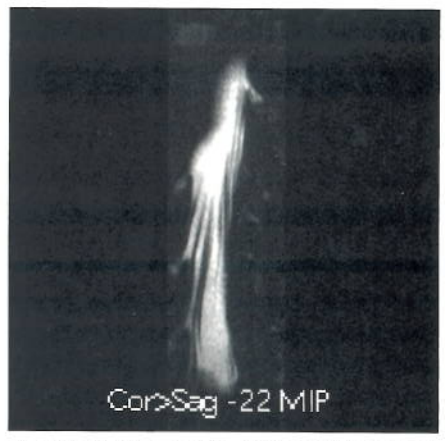
To further reduce background signal without impacting the flow signal, off-resonance RF pulses such as fat saturation (FATSAT) or magnetization transfer suppression (MTS) have been added to some TOF MRA pulse sequences. FATSAT pulses are useful in neck, body, peripheral, and coronary MRA exams for suppressing the large quantity of background fat signal in these areas which tends to obscure the flow signal. MTS pulses are useful in intracranial MRA exams for suppressing the white/grey matter in the brain, thus improving small vessel contrast. Possible drawbacks in using these additional RF pulses include the increased SAR and the extended TR. Refinements such as low bandwidth and asymmetric echo sampling have been combined with MTS and TONE in some sequences such that excellent high resolution scans of intracranial arteries are routinely performed in less than 10 minutes (512 3D TOF MRA).

CLINICAL ARTICLE: Lumbar MR Myelography

Kevin Johnson, R.T.
Research Associate
Abbott Northwestern Hospital, Minneapolis, MN

Although conventional lumbar MR exams have proven effective in evaluating disc disease, traditional lumbar myelography continues to be ordered by referring physicians. MR myelography aids in demonstrating the relationship of the disc to the thecal sac and cord. Early techniques for MR myelography concentrated on T2*-weighted 3D techniques, but recent experiments with T2-weighted 2D Turbo Spin Echo techniques have surpassed the initial results in terms of resolution. Whereas the 3D techniques typically cost 5-6 minutes scan time, the current 2D techniques cost 7-9 minutes. Nerve roots leaving the thecal sac can be assessed by using oblique views acquired with a myelographic technique rather than by using conventional orthogonal views acquired with T1 or T2 technique. Spinal stenosis can be evaluated by looking at the long axis of the nerve as it comes down the canal and exits through the foramen. For evaluating disc herniation, MR myelography in the coronal plane allows additional perspectives of the relationship between disc and thecal sac with a strong T2 contrast technique. Finally, MR myelography does not add any significant time to the overall Lumbar screen exam. We hope that this high resolution MR myelography technique may one day be an acceptable replacement for conventional radiographic myelography.





From the radiologists' perspective, diagnosis can be made from orthogonal images but these supplemental oblique views may provide additional information. These oblique views may begin to satisfy the "old school" doctors who persist in ordering the traditional myelogram.

PROTOCOL: MR MYELOGRAM

TSE27_259B130.WKB, CP SPINE COIL, SCANTIME= 1:38 min,TR= 5800 ms, TE= 259 ms, FLIP= 180 deg, SLICES= 11, THICK= 4 mm, DI= 0.1,SERIES= interleaved, MATRIX= 270x512, PHOS= 60%, ACQ= 1, FOV= 300 mm, RECFOV= 8, SWAP= yes, SHIM= yes, FATSAT= yes, MTS= no.

Acquire studies at six different orientations (coronal, sagittal, cor>sag -22, cor>sag +22, cor>sag -44, cor>sag +44) and generate only 1 MIP projection for each of the acquired orientations.

CLINICAL ARTICLE: Lower Extremity MR Angiography

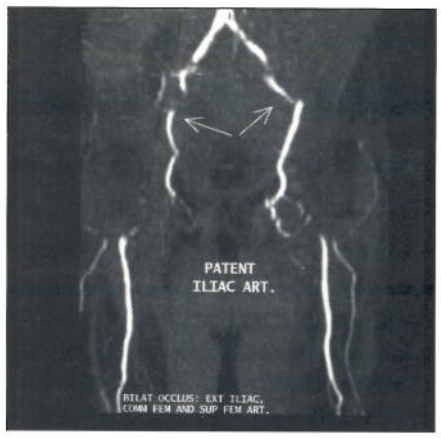
Todd Kennell, M.D.
Radiology Department
V.A. Medical Center, Madison, WI

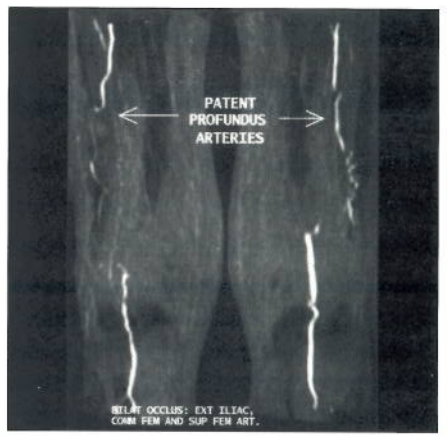
Obtaining good MRA images of both lower extremities in a reasonable amount of time is challenging. Although the pelvis and thighs can be scanned in the Body Coil, small vessels below the knee are not adequately visualized with the Body Coil. Scanning both legs separately in the CP Extremity Coil provides excellent images, but is very time intensive. Our protocol obtains good MRA images from the distal aorta to both ankles in about one hour (45 minutes scan time, 15 minutes setup time). We use the CP Head Coil below the knees and the Body Coil for the pelvis and thighs.

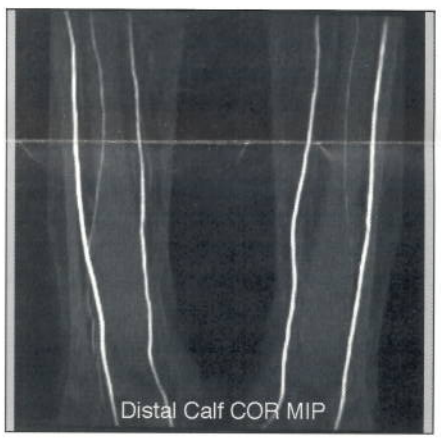
The lower legs are examined in a two-step process: the distal calf exam and the proximal calf exam. Position the patient feet-first and supine. Start with both ankles in the CP Head Coil so that the toes are just outside the end of the coil. With an ink pen, draw a line on the calf at the center of the coil and landmark to this line. Perform the CALF MRA LOCALIZER protocol, followed by two SMALL FOV 2D TOF protocols at shift-means of -55.3 mm and +55.3 mm. These two combined transverse acquisitions will cover 220 mm of the distal calf. Then move the CP Head Coil exactly 200 mm up the legs to a new landmark position and repeat the same three protocols again. This will bring you up to near the knee joint and should include the distal popliteal artery. There will be a 20 mm overlap between the distal calf exam and the proximal calf exam. If both legs do not fit in the CP Head Coil, imaging each leg separately in the CP Extremity Coil with the 165 mm FOV 2D TOF protocol is recommended. This, however, is much more time intensive.

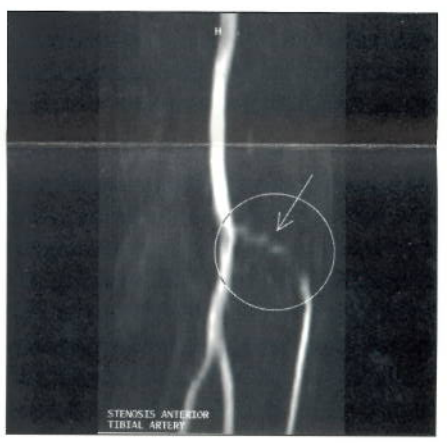
The upper legs are also examined in a two-step process: the pelvis exam and the thigh exam. Switch to the Body Coil and landmark on the femoral heads. Perform the PELVIS MRA LOCALIZER and verify that the distal aorta, just above the bifurcation, will be included in the upper slices of the LARGE FOV 2D TOF protocol positioned at a shift-mean of -87.0 mm. If not, calculate the required shift and re-position the patient table accordingly. After repeating the landmark and localizer (if necessary), perform two LARGE FOV 2D TOF protocols at shift-means of -87.0 mm and +87.0 mm. These two combined transverse acquisitions will cover 347 mm of the pelvis. Without moving the patient, move the table out to a table position 325 mm from current zero (landmark) position and re-zero (re-landmark) the scanner. This will center on the thighs with a 22 mm overlap between pelvis exam and thigh exam. Then perform the THIGH MRA LOCALIZER protocol followed by two LARGE FOV 2D TOF protocols at shift-means of -87.0 mm and +87.0 mm. For average sized patients, this will allow some overlap between the Body Coil exams and the CP Head Coil exams. If there is still a gap (as determined by examining the "copy segments" on the localizers), then move the table out by another 325 mm from the current position and re-zero (re-landmark) the scanner, and perform one more LARGE FOV 2D TOF protocol at shift-mean of -87.0 mm.

Use STUDY/CREATE to combine each pair of 2D TOF studies at each table position. Use all images in each individual study because there is no overlap between each pair of acquisitions. Do a separate targeted MIP for each of the four combined studies. It is critical to use the same localizer image to position both studies from each pair of studies (only changing the shift-means) in order to ensure that the studies combine properly during the MIP process. Never use a FOV less than what is listed in the protocols (even if the patient is small) because the transverse FOV also determines the maximum superior-inferior coverage which can be loaded in the MIP program. You may increase the FOV without detriment, except that resolution will suffer.









We project 6 MIP views every 30 degrees and use a 9:1 format for filming. The first two segments are for localizers with "copy segments" to show the area covered by 2D TOF. The third segment is used for a collapsed axial MIP view from "copy segment" while running MIP. In segments 4-9 we film the 6 projection (MIP) views with all annotation removed (otherwise text overlies vessels).

PROTOCOL: CALF MRA LOCALIZER

FLASH2D_S_8RB195.UFA, CP HEAD COIL,
TR= 20 ms, TE= 8 ms, FLIP= 35 deg, SLICES= 7, THICK= 8 mm,
FOV= 300 mm, SHIFT-MEAN= 0.0 mm, ORIENT= coronal,
SWAP= no, SERIES= ascend, DI= +0.25, MATRIX= 128x256,o, ACQ= 1

PROTOCOL: SMALL FOV 2D TOF

FLASH2D_SD_P_10RB108.WFA, CP HEAD COIL,
TR= 33 ms, TE= 10 ms, FLIP= 40 deg, SLICES= 55, THICK= 3 mm,
FOV= 220 mm, SHIFT-MEAN= +/-55.3 mm, ORIENT= transverse,
SWAP= no, SERIES= ascend, DI= -0.33, MATRIX= 128x256,o, ACQ= 1

PROTOCOL: PELVIS MRA LOCALIZER

FLASH2D_S_8RB195.UFA, BODY COIL,
TR= 20 ms, TE= 8 ms, FLIP= 35 deg, SLICES= 15, THICK= 5 mm,
FOV= 500 mm, SHIFT-MEAN= +15.O mm, ORIENT= coronal,
SWAP= no, SERIES= ascend, DI= 0.0, MATRIX= 128x256,o, ACQ= 1

PROTOCOL: THIGH MRA LOCALIZER

FLASH2D_S_8RB195.UFA, BODY COIL,
TR= 20 ms, TE= 8 ms, FLIP= 35 deg, SLICES= 7, THICK= 8 mm,
FOV= 500 mm, SHIFT-MEAN= 0.0 mm, ORIENT= coronal,
SWAP= no, SERIES= ascend, DI= +0.25, MATRIX= 128x256,o, ACQ= 1

PROTOCOL: LARGE FOV 2D TOF

FLASH2D_SD_P_10RB108.WFA, BODY COIL,
TR= 33 ms, TE= 10 ms, FLIP= 40 deg, SLICES= 58, THICK= 4 mm,
FOV= 350 mm, SHIFT-MEAN= +/-87.0 mm, ORIENT= transverse,
SWAP= no, SERIES= ascend, DI= -0.25, MATRIX= 128x256,o, ACQ= 1

PROTOCOL: 165 mm FOV 2D TOF

FLASH2D_SD_P_10RB108.WFA, CP EXTREMITY COIL,
TR= 33 ms, TE= 10 ms, FLIP= 40 deg, SLICES= 64, THICK= 3 mm,
FOV= 165 mm, SHIFT-MEAN= 0.0 mm, ORIENT= transverse,
SWAP= no, SERIES= ascend, DI= -0.15, MATRIX= 128x256,o, ACQ=1

TECHNICAL ARTICLE: 3D and 2D Multislab MRA

Cyndi Hancock, R.T.
MRI Application Specialist
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MR Angiography (MRA) often relies upon multiple, sequential acquisitions to either increase anatomical coverage or to minimize flow voids from RF saturation of flowing spins. The key factor to remember is that with 3D sequences there must be some overlap between the multiple slabs, but with 2D sequences the multiple stacks must be contiguous (no overlap or gap).

DATA ACQUISITION FOR 3D MULTISLAB

Multiple, overlapping 3D slabs may be used to image fast arterial flow. This technique is not recommended for venous flow or even moderately slow arterial flow due to the excessive RF saturation of flowing spins within the slab. With the 3D multislab technique, it is necessary to use relatively thin slabs (approximately 30 - 40 mm) and to slightly overlap them (approximately 30 %) in order to eliminate the edge partitions with decreased signal intensity from the MIP processing. The thickness of the slabs may be almost doubled if TONE pulses are used, but the slight overlap (approximately 30 %) should still be used. Since images should always be loaded into the MIP program in ascending anatomic order, the multiple 3D slabs should always be acquired from patient's superior toward inferior, whether patient is lying head-first or feet-first. A convenient rule-of-thumb is to overlap by 20 slices when acquiring a 64 partition data set, or overlap by 10 slices when acquiring a 32 partition data set.

CHECK FOR COVERAGE

First, graphically position the most superior slab with the SLICE/AUTO menu (MAGNETOM SP) or the POSITION menu (MAGNETOM Open, Impact and Vision). Return to the CHANGE menu and round off the SHIFT(MEAN) value of the first slab to a nice whole number (e.g., - 43.7 becomes - 45.0). Before starting the exam, check to see how many slabs will be required for adequate coverage. Determine the appropriate SHIFT(MEAN) value for the second slab (according to the guidelines below) and enter that SHIFT(MEAN) value into the CHANGE menu, then return to the graphical positioning menu to check for adequate coverage with the two slabs. If the coverage is inadequate, repeat the process for additional slabs as necessary. Finally, return to the CHANGE menu to enter the SHIFT(MEAN) value of the first slab and begin the measurement. While this is scanning, enter the SHIFT(MEAN) value of the next slab and begin that measurement after the first scan is completed.

64 PARTITIONS:

80mm slab thickness = 1.25mm effective slice thickness,
1.25mm effective slice thickness x 20 slices = 25mm overlap,
80mm slab thickness - 25mm overlap = 55mm shift between slabs,
change SHIFT(MEAN) by exactly 55mm toward the inferior direction.

64mm slab thickness = 1.0mm effective slice thickness,
1.0mm effective slice thickness x 20 slices = 20mm overlap,
64mm slab thickness - 20mm overlap = 44mm shift between slabs,
change SHIFT(MEAN) by exactly 44mm toward the inferior direction.

52mm slab thickness = 0.8mm effective slice thickness,
0.8mm effective slice thickness x 20 slices = 16mm overlap,
52mm slab thickness - 16mm overlap = 36mm shift between slabs,
change SHIFT(MEAN) by exactly 36mm toward the inferior direction.

32 PARTITIONS:

40mm slab thickness = 1.25mm effective slice thickness,
1.25mm effective slice thickness x 10 slices = 13mm overlap,
40mm slab thickness - 13mm overlap = 27mm shift between slabs,
change SHIFT(MEAN) by exactly 27mm toward the inferior direction.

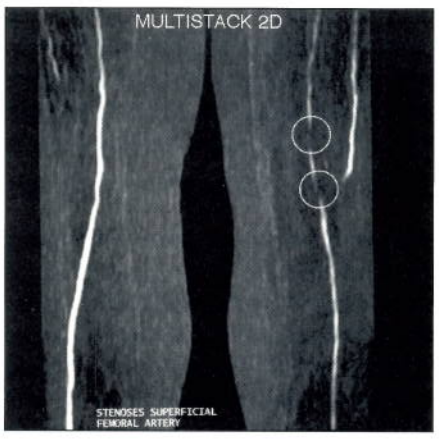
32mm slab thickness = 1.0mm effective slice thickness,
1mm effective slice thickness x 10 slices = 10mm overlap,
32mm slab thickness - 10mm overlap = 22mm shift between slabs,
change SHIFT(MEAN) by exactly 22mm toward the inferior direction.

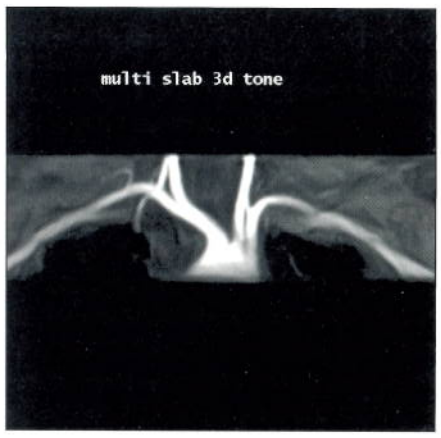
26mm slab thickness = 0.8mm effective slice thickness,
0.8mm effective slice thickness x 10 slices = 8mm overlap,
26mm slab thickness - 8mm overlap = 18mm shift between slabs,
change SHIFT(MEAN) by exactly 18mm toward the inferior direction.

Note for SP users: contact Helmuth Schultze-Haakh (1-800-753-6336 ext. 2117) for a command procedure which will set-up 3D MULTISLAB acquisitions for you and also provide the image numbers for the MIP reconstruction.

DATA ACQUISITION FOR 2D MULTISTACK

Multiple, contiguous 2D stacks may be used to image venous flow, moderately slow arterial flow, and even fast arterial flow. Since the slices are extremely thin (approximately 2 - 5 mm), RF saturation of flowing spins within the slice is minimized, but with a penalty in resolution compared to 3D techniques. With the 2D multistack technique, it is not necessary to overlap the stacks since none of the edge slices will be eliminated from the MIP processing. The 2D stacks should be acquired without overlap or gap between stacks, although the individual slices within each stack must slightly overlap (approximately 30-50 %) among themselves. The multiple 2D stacks should be acquired from the patient's superior toward inferior.





50 SLICES:

effective slice thickness = (1 + -.33) x 3mm = 2mm,
area of coverage = 2mm x 50 = 100mm,
shift between stacks = 100mm,
change SHIFT(MEAN) by exactly 100mm toward the inferior direction.

40 SLICES:

effective slice thickness = (1 + -.25) x 4mm = 3mm,
area of coverage = 3mm x 40 = 120mm,
shift between stacks = 120mm,
change SHIFT(MEAN) by exactly 120mm toward the inferior direction.

35 SLICES:

effective slice thickness = (1 + -.20) x 5mm = 4mm,
area of coverage = 4mm x 35 = 140mm,
shift between stacks = 140mm,
change SHIFT(MEAN) by exactly 140mm toward the inferior direction.

Note: the thicker slices should be used for larger vessels, e.g. the vena cava. Since the coverage in one stack is rather large, only two stacks should be used. Center the patient in the middle of the complete range of coverage using a slice shift of half the area of coverage to the negative side (superior) and then again to the positive side (inferior). For example, two stacks of 100mm coverage each should be acquired with one stack at a shift of -50mm and the other stack at a shift of +50mm. The total area of coverage will be 200mm. All 2D sequential time of flight acquisitions should be done using an ascending slice series.

MIP PROCESSING

With 3D MULTISLAB acquisitions, it is necessary to exclude overlapped slices from each overlap region in order to avoid dark bands through the middle of the MIP images. For 64 Partition data sets, exclude 20 slices from each overlap region (10 slices from each slab). For 32 Partition data sets, exclude 10 slices from each overlap region (5 slices from each slab). However, with 2D MULTISTACK acquisitions, it is unnecessary to exclude any slices during the MIP processing. Always, when specifying the desired image numbers to be combined and loaded into MIP, be sure to specify them in the correct anatomical order from superior toward inferior, regardless of the actual order in which they were acquired.

MAGNETOM SP: Unnecessary to create a combined study to load into the MIP process. Display an image from one of the 3D data sets, select 3D Processing from the main menu, select MIP, select Base Data, enter the desired ranges of image numbers to be loaded in MIP, select Load, perform MIP processing as usual. For example, enter images (4-30,41-67) for a 3D MULTISLAB acquisition with 2 slabs of 32 partitions each, or enter images (4-53,54-103) for a 2D MULTISTACK acquisition with 2 stacks of 50 slices each.

MAGNETOM Open and Impact: Necessary to create a combined study to load into the MIP process. Select Study/Create from the main menu, enter the new study name (e.g., Multislab), enter the patient name, enter the desired ranges of image numbers to be combined into the new study, select Go, choose Study/Select from the main menu, display an image from the new combined study, select MIP, select Load, perform MIP processing as usual.

The Alien Sign

A new MRI "sign" has just been reported - the "Alien Sign" . So, if you encounter this type of image during a neuro workup for hydrocephale, beware of possible close-encounters-of-the-tabloid-kind. (Image courtesy of Weekly World News)

CLINICAL ARTICLE:
Coronal 3D Abdominal MRA

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In body MRA, covering long arterial segments with multiple transverse MRA sequences is very time consuming. In large aneurysms with slow turbulent flow, the flow signal becomes saturated. Standard coronal 3D time-of-flight (TOF) protocols are not effective for long arterial segments due to in-plane saturation of flow signal. If Gadolinium contrast is injected as a bolus for a 3D MRA exam, the contrast will mainly enhance the venous system due to the rapid passage through the arteries long before the 3D sequence can be completed. However, by injecting the contrast slowly by hand during the acquisition, low levels of contrast enhancement can be achieved in arteries to overcome the effect of signal saturation. It is postulated that the veins do not enhance because sufficient contrast enters the extravascular spaces to lower the venous concentration. The abdominal aorta, iliac arteries, and proximal leg arteries can be imaged in a single 5 to 6 minute coronal 3D acquisition. When combined with breath-hold FLASH2D T1 sagittal and transverse sequences for evaluating anatomic relationships, all the information necessary for pre-surgical evaluation of aortic and/or iliac aneurysms can be obtained in a very reasonable amount of time. The contrast dosage used by Prince, et. al. (Ref) was 0.2 mmol/kg. In the case illustrated below, we used 20 cc of contrast (0.15 mmol/kg for this patient) in order to not exceed one unit charge for contrast.

We have tried this technique for the aortic arch also. In the illustrated case, severe stenoses at the origin of the innominate and left subclavian arteries contained flow voids on both transverse MRA and the enhanced coronal MRA. However, the coronal MRA provided much better vessel contrast and visualized a longer length of the arteries. Venous enhancement was seen in the neck that became more saturated inferiorly. It is possible that this occurred because contrast does not cross the blood-brain barrier, thus creating a higher concentration of contrast in the jugular veins than would be present in the iliac veins. It was still possible to visualize the brighter arteries. The veins can also be excluded by using MPR to create left anterior oblique images of the branches of the aortic arch.

The advantages of this technique include decreased scan time and improved vessel contrast. The disadvantages include relatively low spatial resolution, the cost of the contrast agent, and the limitation that it cannot be repeated for a second scan (because of the repeat dose of contrast).

On our MAGNETOM SP63 (1.5 Tesla) scanner we use a standard FISP3D MRA sequence without TONE, 350 - 450 mm FOV, 96 mm slab, 64 partitions, 192 x 256 matrix, 29 - 30 ms TR, 6 - 7 ms TE, 40 degree flip, no presats, coronal, no swap, no recfov, no filter. Center the patient at the iliac crest and start a running IV. Obtain scout images in the transverse plane: 3 slices, 10 mm thick, distance factor 20.0 (one slice at isocenter, one slice very superior, and one slice very inferior to aid in alignment of the coronal 3D slab). After obtaining breath-hold sagittal and transverse FLASH2D_4ms images of the aorta for measurement purposes, use a sagittal image to align the coronal 3D slab. The anterior margin of the aneurysm must be not less than 5 mm inside the anterior margin of the slab to allow for the degraded partitions at the edges of the slab. Often it will be necessary to angle the slab to include the iliac branches down to the inguinal region, and thus the upper abdominal aorta may be outside the 3D slab (this segment is usually of little interest). Because the position of the iliac arteries will not be seen on a midline sagittal scout image, check their position by placing the coronal 3D slab on the most inferior axial scout image. The iliac arteries should be as far within the slab as possible. In the referenced article, a slab thickness of 128 mm was used, but this is not allowed on our sequence. Therefore, with large aneurysms, it may not be possible to include the distal iliac arteries. Load and start the sequence. Begin a slow infusion of Gadolinium contrast into the running IV approximately 5 seconds after the sequence starts. The injection should end approximately 20 seconds before the sequence ends. For a 20 cc injection, this results in a rate of 1 cc every 16 seconds. Flush with 20 cc of saline at the end of the injection.

(Ref): Prince, M.R., et. al. Dynamic Gadolinium-enhanced Three-dimensional Abdominal MR Arteriography. JMRI 1993;3:877-881.

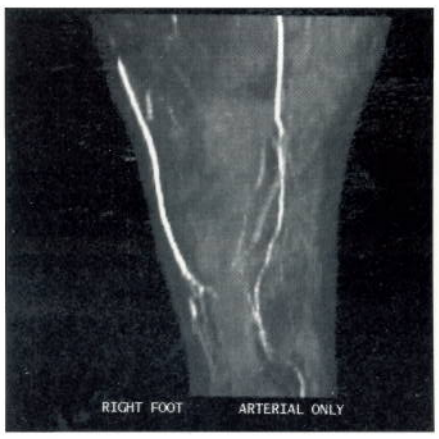
CASE HISTORY:
Lower Leg MRA in Diabetes

Stephen F. Cool, R.T.
Carrie Blaydon, R.T.
Southern Oregon Imaging, Medford, OR

We typically examine only the arterial phase, but occasionally we examine the venous phase or the combined arterial/venous phases. We then MIP in 19 degree increments and film on a 12:1 format in both positive and negative formats. For the arterial phase, we use flash2d_sd_p_10rb108.wfa, TR= 31, TE= 10, FA= 45 (possibly increase to 60 in foot), Thick= 3, FOV= 200, TA= 8:29, Slices= 64, Di= -.30, MA= 224x256, AC= 1, swap= no, OR= transverse, Series = ascend, Filter = Hanning(weak). For the venous phase, we use flash2d_su_9rb195.ufa, TR= 35, TE = 9, Flip = 45°, Thick = 3, FOV = 200, TA = 9:28, and all remaining parameters same as above. For the combined arterial/venous phase, we use flash2d_s_8rb195.ufa, TR = 20, TE = 8, Flip = 45°, Thick = 4, FOV = 300, TA = 5:52, and all remaining parameters same as above.

History: A 43 year old male was presented to us with diabetes, renal insufficiency, ischemia, atherosclerosis, and gangrene of the right foot. A vascular surgeon wanted us to do an MRA instead of a conventional angiogram due to the patient's medical history. He wanted to determine if he could revascularize the patient's lower leg and eliminate the need to amputate. The surgery was scheduled based entirely upon the MRA results, but the patient developed infection and surgery was cancelled.

Technique: Prior to scanning, we have our patients drink 12 oz. of a caffeinated drink (coffee or cola) and, if possible, jog in place for about 5 minutes to increase the peripheral blood flow. On our MAGNETOM Impact system, our patients are scanned in the CP Extremity Coil from knee to foot and in the Body Coil from pelvis to knee.

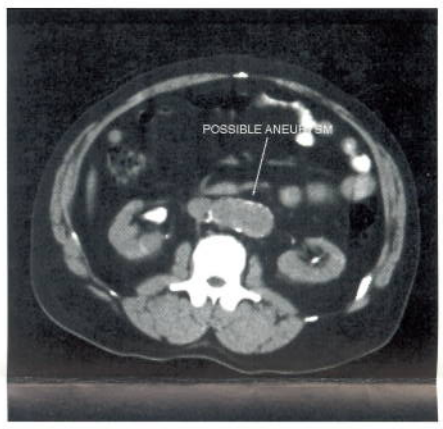


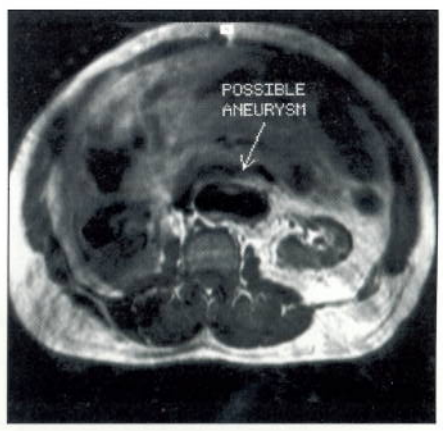
CASE HISTORY:
False Aortic Aneurism

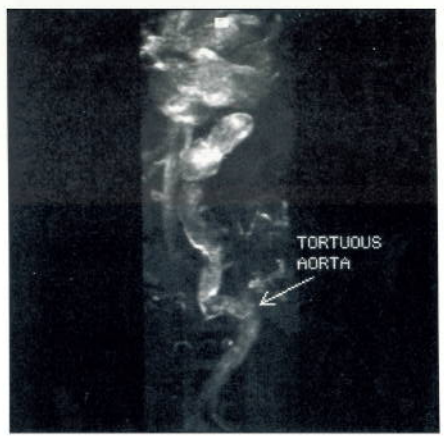
Gary Zwicky, M.D.
Colleen Kenny, R.T.
Marcella James, R.T.
Radiology Department
St. Francis Medical Center, Peoria, IL

History: The patient presented at the emergency room with pain, tightness and burning in the chest, and a history of three previous aortic aneurysm surgeries. A subsequent CT scan showed a probable fourth aortic aneurysm. To better evaluate the patient, an aortic MR angiogram was performed. The MIP processed images showed that the patient did not have an aneurysm, but rather just a very tortuous aorta. This patient was properly diagnosed and spared surgery or an invasive x-ray angiogram by having this MR angiogram exam.

Technique: On our MAGNETOM 63SP with A2.7 software, we used the Siemens breath-hold protocol 2D_BH_TRIG_SINGLE_PHASE with the standard Body Coil. The patient was instructed in the breath-hold technique prior to the scan and performed very well. MR images were acquired in the coronal plane with a shift of 4mm between slices.

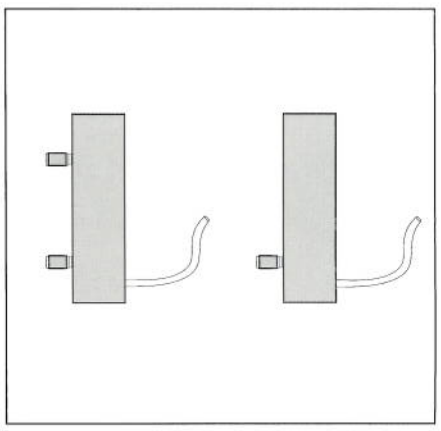


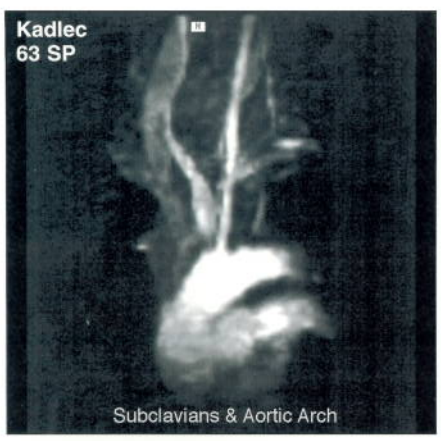


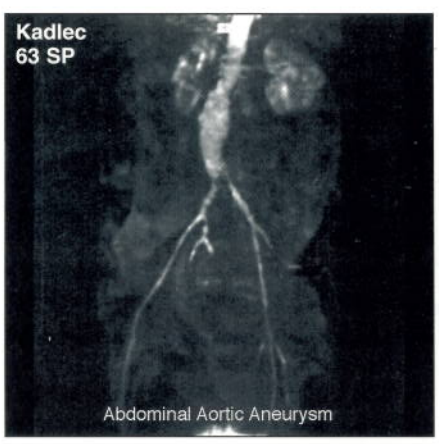


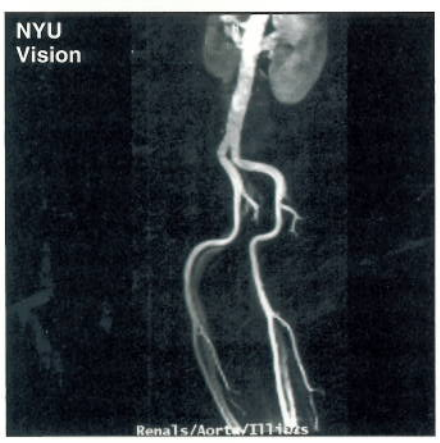
COIL FACTS

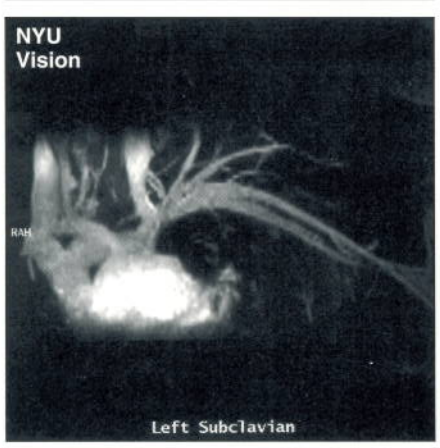
Transmit/Receive coils have two coaxial pins on their plug. but Receive/Only coils have only one coaxial pin.

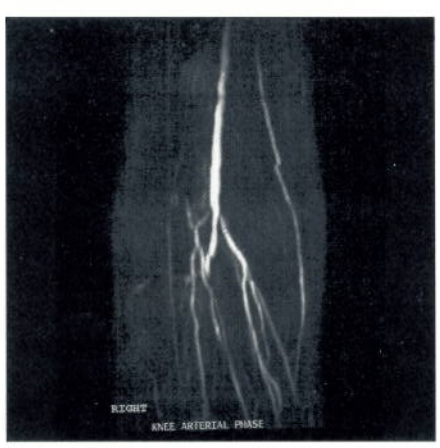












Applications Tip: Receiver Adjust

Conventional pulse sequences acquire multiple slices in an interleaved fashion within a long TR. "Sequential" pulse sequences acquire multiple slices serially, one slice at a time within a minimum TR. The designation "_S_" is used in the name of all "sequential" sequences to differentiate them from conventional multislice sequences. 2D time-of-flight MR angiography uses "sequential" sequences either with or without breath-holds, either with or without traveling saturation bands, either with or without cardiac triggering. For conventional multislice sequences, the receiver adjustment is performed very quickly for all the slices in the stack, but for "sequential" sequences the receiver adjustment can be very time consuming if lots of slices are to be acquired. This is particularly true if there is a built-in breath-hold delay period (TD) between slices in the sequential acquisition. It may be desirable to use an offline receiver adjustment with "sequential" sequences rather than the inline receiver adjustment typically used for conventional multislice sequences.

OFFLINE RECEIVER ADJUSTMENT FOR MAGNETOM SP SYSTEM

1. Select your desired protocol and graphically position the slices.
2. Set INLINE ADJUST = OFF in the CHANGE menu (this may be saved in the protocol).
3. If more than three slices were positioned, temporarily change to only three slices.
4. Go back into main menu and type ADJ/REC on the keyboard to manually adjust the receiver (do not go into ADJUST/ RECEIVER/ CONTROL menu).
5. If necessary, change back to the original number of slices now without graphically repositioning them. Verify that the slice position (shift) and the distance factor (di) have not changed.
6. For a breath-hold exam, do SEQUENCE/LOAD immediately and do SEQUENCE/START when ready to begin. For a non-breath-hold exam, do SEQUENCE/MEASURE.
7. If performing a series of scans with the same group of slices at different positions, simply change the shift-mean position in the CHANGE menu and repeat step 6 as often as necessary.

OFFLINE RECEIVER ADJUSTMENT FOR MAGNETOM OPEN, IMPACT, VISION SYSTEMS

1-3. Same as above.

4. Go into MEASUREMENT/ ADJUST/ RECEIVER menu and select START as many times as necessary to manually adjust the receiver, then select SAVE and exit the platform with APPLY.

5-7. Same as above.

ASK EXPERTS: Renal MRA

Ralph E. Lee, M.A., R.T.
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University of California, VA, San Francisco, CA

Question

We have been getting good images on some renal MRA patients and poor images on others. Does anyone have a protocol that consistently gets good results?

Answer

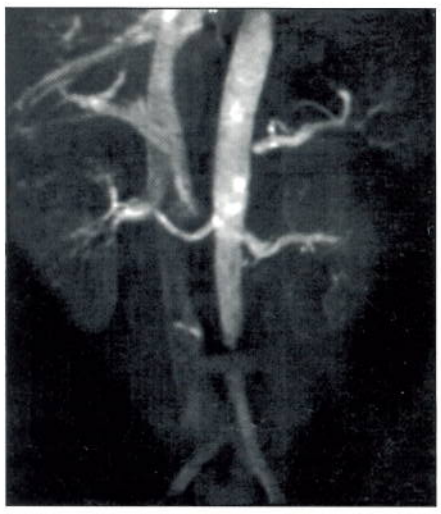
Most of us have found renal MRA to be somewhat patient dependent. Sometimes we get great images, but sometimes we don't. The "when" and "why" largely depend on patient considerations rather than operator skill.

The unfortunate thing about this type of referral is that clinicians often seem to consider MRA first only for patients too sick for contrast angiography (extreme renal compromise and/or poor cardiac output). This can be a real problem in extreme cases: poor blood flow means poor MRA images.

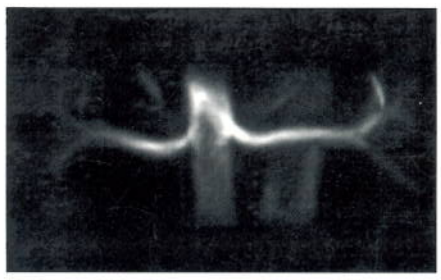
In my experience, the most reliable approach is the old-fashioned 2D time-of-flight breath-hold approach (i.e., 5 to 7 mm slices, one at a time, with a 30 to 50 % overlap). Both a series of axials and coronals should be filmed as individual slices. MIP's can be considered a "bonus" if the patient can repeatedly suspend respiration in the exact same phase of expiration for every slice.

Siemens scanners offer a variety of 2D renal protocols. I have had my best success with the FLASH2D, one slice, "breath in, breath out, hold it" approach. On our MAGNETOM SP system, there is a FLASH2D_BH (breath-hold) sequence with a built in TD (time delay = pause to catch the breath) and audible clicks that automatically prompt the patient when to hold his breath. I get good images when using this approach with alert patients, but rarely do the slices line up perfectly for a MIP. Another option available on most MAGNETOM systems is the 2D time-of-flight, cardiac triggered, segmented k-space sequence which acquires one slice per breath-hold. This sometimes provides a bit of extra flow signal in marginal cases because the data acquisition is triggered to the period of fastest blood flow in the vessels.

Many sites have found axial 3D time-of-flight sequences (with TONE) or axial 3D phase contrast sequences to be useful adjuncts to the 2D methods. But keep in mind that the diameter of the renal arteries with these 3D sequences will appear slightly narrowed compared to 2D methods as the result of respiratory motion and partial loss of signal from slower moving blood along the vessel walls.



MIP of 2D TOF triggered breath-hold renal



MIP of 3D phase contrast renal

MIP of 3D TOF renal with TONE

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