3T MRI is better: Size does matter

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Citation

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Abstract

Dr Philip W Chao has worked in Delaware to produce the best MRIs possible since 1990. He has monitored hundreds of thousands of MRIs over his career at the University of Pennsylvania and working for the people of Delaware. He is perhaps one of the best trained doctors in MRI in the world and Delaware

After having a 3T MRI for more than a year I think it is reasonable to write a short article on why 3T MRI is better. On a physics basis 3T MRI has twice the signal to noise. There is nothing better than more signal. It gives you great flexibility. It makes the images crisp and clear and allows you to do super high resolution 1024x1024 studies or super fast studies for breathold abdominal imaging in 17 seconds, or injected MR angiograms in 10 seconds. So just from physics the scanner is better but I think real world examples are better.

We often get asked to repeat equivocal studies at 1.5T, 0.3T or 1.0T. 3T is always better in any area as long as you have the proper surface coil. When you compare any study and repeat it at 3T the extra signal makes you able to cut thinner or scan with higher resolution and get better vessel detail. We see smaller branch vessels in injected and non-injected MRA studies. So repeating the test for equivocal aneurysms is one of our most requested studies. We also repeat the test for grading of stenosis or characterization of plaque type.

One of the studies I really like to do is to look for superficial temporal arteritis. By scanning the head with 2mm thick sections 1024x1024 matrix and fat sat with gad, we can pick up superficial temporal arteritis without a biopsy. It is a major cause of headaches and very few doctors know that MRI is 98% sensitive and specific for this diagnosis. Another great study that we can do at 3T is to use TRICKS – which is a time resolved angiogram. We use this to look at the foot vessels or actually any area of the body which is 31 cm in diameter. So the past two days we actually did two of these studies to look at the carotid bifurcation and the arch – you get them both with one shot. One showed a tortuous carotid artery misdiagnosed as an aneurysm. The other showed a 50% long segment narrowing of the internal carotid with 20% narrowing of the right subclavian. The key here is that at 3T with TRICKS you never miss. You get an incredible angio of one area every time. Just inject and scan.

One thing I always am amazed is the quality of the brain MRI studies at 3T. The background is totally black. There is such a smooth depiction of the gray what matter junction and you see details which simply are obscured by noise at 1.5T. The venous and arterial anatomy is amazing at 3T. I suppose it is the higher resolution we scan at. But I can usually pick up aneurysms on the routine images and then we just do an MRA (3D TOF) study to confirm it. SAR (specific absorption rate) becomes a problem if the patient has a larger than normal head. Fortunately this is not generally a problem but the solution is to use the accelerated head protocol. We have so much signal we can accelerate up to 4x and still get diagnostic images. So imaging of the brain is possible in under 5 minutes at 3T. This morning we had a nice case of tuberous sclerosis in a 25 y.o. child who was mentally retarded but we got a great study. This was in part due to the rapidity of the scans. Another thing is the added sensitivity to hemorrhage. Because sensitivity to blood products is about tripled at 3T. There have been cases of cerebral amyloid angiomatosis which I picked up 150 brain lesions and this was missed by two other 1.5T scans on the same patient. They saw one area of hemorrhage but missed the 149 additional lesions.

In the cervical spine using 3T we can get 2mm contiguous scans in the sagittal plane. At 1.5 T we usually can do a gradient echo 3D 2mm thick axial image or even 1.5mm thick on some scanners and get reproducible quality. At 3T the 512x512 sagittal PD images accentuate the edges of herniations so they always stand out. This is the test that says the buck stops here. If you do not have a disc herniation

on our 3T scanner – you simply do not have one. There is no place for the disc to hide.

The soft tissues of the neck require the use of hyperechoes so we can not run into SAR problems when we scan in the axial plane. In the sagittal and coronal planes SAR is slightly less due to the gradient configuration and the simple fact that the anatomy is less slices in these planes. Less slices means less SAR. I suppose you get the drift of my article. Part of having experience at 3T is to understand where you might run into a SAR issue and know immediately how to deal with it. The simple easy answer is when you hit a SAR barrier accelerate over it. It works most of the time. In the cases where it does not work – switch to gradient echos which deposit less SAR. Don't forget to do diffusion imaging. It is amazing what diffusion imaging can add to body imaging. In the brain we know it detects tumors and strokes. In the body it detects adenopathy, liver tumors and pancreatitis. In the abdomen it can show lymphoma, enlarged nodes and also soft tissue implants in the omentum and peritoneum.

In the musculoskeletal system 3T is king. I love 2mm thick contiguous images. I do that in almost all areas we scan. One thing you can consider at 3T is the indirect arthrogram. We do them of the knee, hip and shoulder. You can get 2mm or less thick images with T1W VIBE contrast. We have excellent visualization of the labrum and internal structures of the joints but you also get incredible imaging of tendinitis. Any inflammation will light up like a light bulb with 3T and good fat sat T1W images. All musculoskeletal studies are improved by the higher resolution, better fat sat and contrast sensitivity. Basically I have seen subtle injuries to the knee and subtle stress fractures which would have been missed by other scanners. The increased trabecular detail is a well known advantage of high field (ultra high) 3T MRI. The other thing I truly appreciate is the speed of the imaging. In our wrist coil or in the extremity coil you almost never hit a SAR problem and we scan 3mm thick images 1 excitation. This means we get each plane in about 2 minutes. At 1.5T each plane can take up to 5 minutes and this really means you get a lot of motion on your studies. In the wrist also.. the arthrograms are beautiful.

In the abdomen the MRA studies are super fast and can be accelerated to 10 second breatholds. This is wonderful for older patients. I tend to like using TRICKS however because there is less of a timing issue but in areas where there is respiratory motion I do use breatholding. One of the other flexible things you have at 3T is the ability to reduce your field of view to as little as 24cm and scan with 3mm thick sections. I generally don't like to scan with a smaller than 24 FOV using the body array but in some limited circumstances you can probably do a 20 cm field of view with slightly thicker sections. Again we eliminate most of our SAR issues by using 3D VIBE image in pre and post and dynamically. This lets us pick up smaller pancreatic lesions. And the combination with diffusion weighted imaging lets us pick up even subtle pancreatitis. And for the only disadvantage that I see is the dielectric effect B1 inhomogeneity shading. By using more intelligent excitations which is a new technology from Siemens I think that B1 inhomogeneity will be reduced. It will take a year or two of study to see if this really works in the real world. The new 3T 70 cm bore Verio has a cylindrical excitation which hopefully will prove to be very robust. I know the only east coast installation and they love their Verio.

For breast MRI I believe that the increased sensitivity to contrast and the higher resolution of the scans and increased signal to noise all help to increase sensitivity and specificity of breast MRI studies. I think the detection of subtle enhancing nodules of DCIS is improved at 3T. But I do think it will take years of comparative studies to tease out this data. I do however feel that the increased speed, increased resolution can't be worse…

In the thoracic and lumbar spine the axial images are beautiful at 3T. I use the 2.5mm thick contiguous images in the spine in the sagittal plane and pick up every little annular tear and bulge as well as herniations. It is also good for interspinous ligament sprains and strains and subtle stress fractures of the pedicles or spondylolysis. In the axial plane I only use 3-4mm thick imaging to get sufficient coverage.

Pelvis MRI is also incredible. We get great fat sat and using contrast you pick up subtle areas of inflammation easily using fat sat VIBE T1W images. You can reduce the field of view to 24cm. We get images of the prostate that rival surface coil images without the rectal coil. With a rectal probe the images are simply the best you can get in the world. My friend who has the 3T Verio combines prostate imaging and spectroscopy for his patients. In the U.S. there is no reimbursement for spectroscopy but I truly do feel this is an important advance in both breast and prostate imaging. I will be getting REVEAL (diffusion weighted imaging) with my new Espree and will combine that with a prostate coil to get real world data at 1.5T.

In short every day the added abilities of 3T increase

throughput and allow me to make diagnoses that I simply could not make before I had the 3T. I will be happy to answer any questions you might have – just send them to me via sumerdoc@yahoo.com Thanks… Philip W Chao MD

References

Author Information

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