

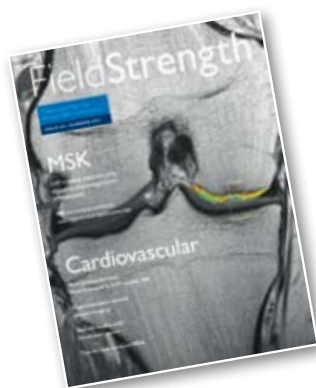
FieldStrength

Publication for the
Philips MRI Community

ISSUE 44 – SUMMER 2011

Metal artifact reduction for MRI of metal prostheses and implants

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This article is part of FieldStrength issue 44
Summer 2011



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Metal artifact reduction for MRI of metal prostheses and implants*

Patients suffering from pain after receiving hip or knee implants may have soft tissue disease. MRI is ideal for soft tissue sensitivity, but the metal implant causes magnetic field disturbances leading to an artifact which complicates image interpretation. Metal artifact reduction sequences (MARS) are less sensitive to metal artifacts. These tips show how to adapt your scans to reduce the metal artifacts. ExamCards will be available on NetForum shortly.

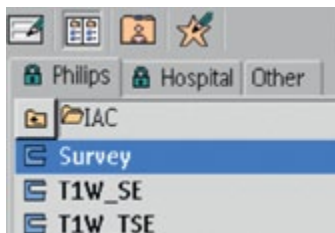
*See note on bottom of page 21

TIP 1

Use TSE instead of FFE

TSE will show less pronounced metal artifacts than gradient echo sequences (FFE and TFE), because of the refocusing pulses used in TSE.

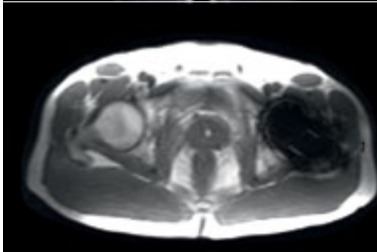
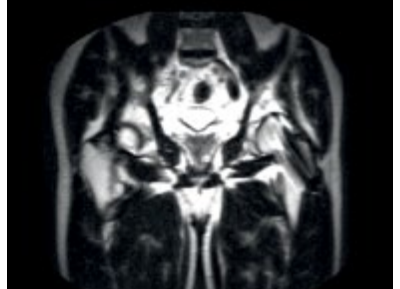
So, use preferably TSE sequences instead of FFE. Also use a TSE survey – an example can be found in the IAC preset protocols:



TFE: strong metal artifact



TSE: less metal artifact



TIP 2

SENSE or CLEAR

Switch off SENSE and CLEAR; Select no in the Geometry tab. Without SENSE or CLEAR, the reference scan can also be removed from the ExamCard to save scan time.

initial	geometry	contrast	motion	dyn/ang	pc
Nucleus			H1		
Coil selection			SENSE-XL-Torso		
element selection			All		
connection			d		
Dual coil			no		
CLEAR			yes		
body tuned			no		
FOV	FH (mm)		yes		

TIP 3

Use short echo spacing and high TSE factor

Nowadays, asymmetric TSE allows more direct control of ES, and the TSE factor can be increased to speed up the scan. Don't make the TSE shot larger than about 4 x TE to avoid blurring. In older releases with linear profile order, a short echo spacing (ES) could be only obtained by setting a high TSE factor.

initial	geometry	contrast	motion	dyn/ang	pc
Scan type			Imaging		
Scan mode			MS		
technique			SE		
Modified SE			no		
Acquisition mode			cartesian		
Fast Imaging mode			TSE		
shot mode			multishot		
TSE factor			20 (8)		
TE spacing			user defined		
(ms)			6 (14)		
startup echoes			0		
profile order			asymmetric		
DRIVE			low_high		
ultrashort			linear		

Total scan duration	04:36.0
Ref. signal level (%)	28.7
Act. TR (ms)	3000
Act. TE (ms)	30
ACQ matrix (mm)	440 x 440
ACQ voxel MPS (mm)	0.80 / 1.02 / 3.00
REC voxel MPS (mm)	0.70 / 0.70 / 3.00
Scan percentage (%)	78.6
Packages	2
Min. slice gap (mm)	3
WFS (vox / BW (Hz))	0.778 / 279.0
TSE es / shot (ms)	6.0 / 120

TIP 4

Use a small WFS of 0.5 to 0.7

Use a small WFS of 0.5 to 0.7; this corresponds to a high bandwidth. For more explanation, see application tip in FieldStrength issue 36, Dec. 2008.

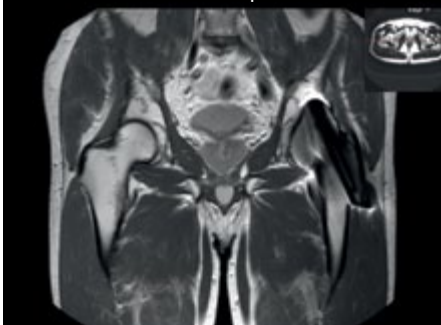
These low WFS values require strong gradients, so use gradient mode maximum.

If you still can't reach the low WFS, then you may set it to minimum. It is not recommended to do this from the beginning, as WFS may become lower than needed, which leads to low SNR.

initial	geometry	contrast	motion	dyn/ang	pc
partial echo			no		
TE			user defined		
(ms)			30		
Flip angle (deg)			90		
Refocusing control			no		
TR			range		
minimum (ms)			3000		
maximum (ms)			4000		
Halfscan			no		
Water-fat shift			user defined		
(pixels)			0.5 (2)		

Diffusion mode	regular
Elastography mode	default
SAR mode	user defined
BI mode	full control
SAR Patient data	maximum
PNS mode	enhanced
Gradient mode	enhanced-max
Softone mode	no

WFS 2, bandwidth 110 Hz/pixel



WFS 0.5, bandwidth 440 Hz/pixel



TIP 5

Use thin slices

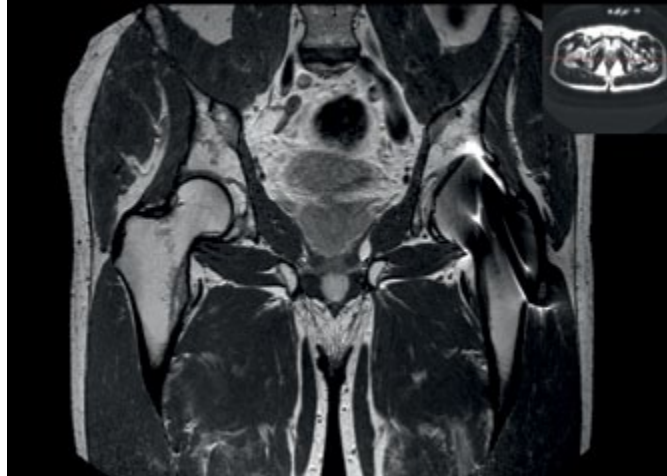
Selecting thin slices will need a strong slice selection gradient, which is similar to setting a high bandwidth for the readout, and thus will decrease through-plane artifacts, as seen in this example.

initial	geometry	contrast	motion	dyn/ang	pa
Coil selection	SENSE-XL-Torso				
element selection	All				
connection	d				
Dual coil	no				
CLEAR	no (yes)				
FOV	FH (mm)	360			
	RL (mm)	450			
	AP (mm)	81 (153)			
Voxel size	FH (mm)	1.4			
	RL (mm)	1.75			
	Slice thickness (mm)	3 (6)			

Voxels $0.8 \times 1.0 \times 6$ mm



Voxels $0.8 \times 1.0 \times 3$ mm

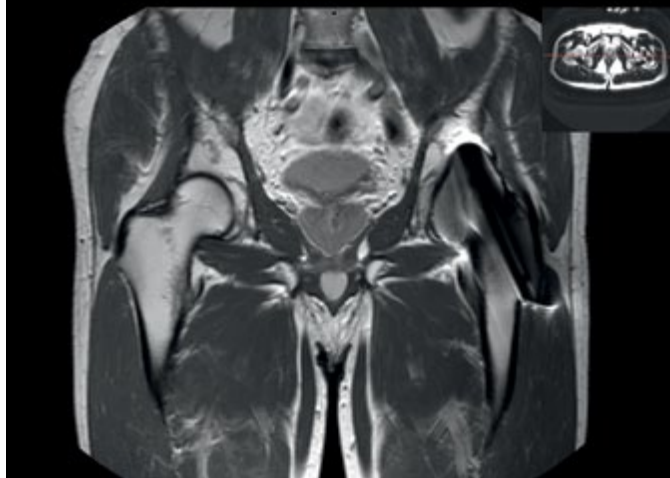


TIP 6

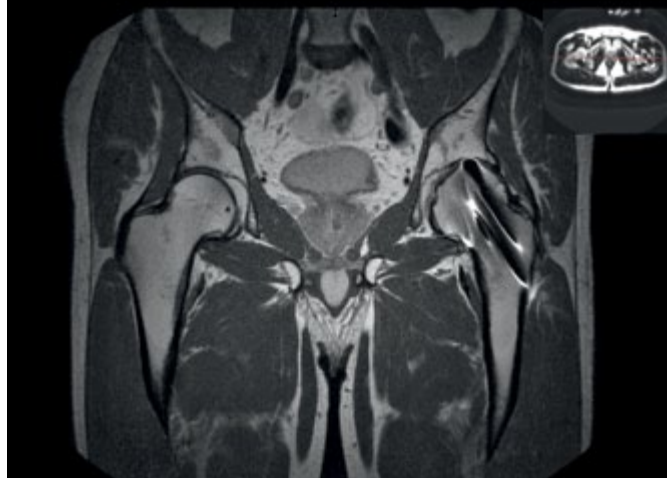
Maintaining good SNR

Increase NSA to compensate when measures of the previous tips cost some SNR. The typical scan time of a MARS protocol is about 5 minutes. If you want to further increase SNR, give up some in-plane resolution first.

Standard PDW TSE



MARS – everything together

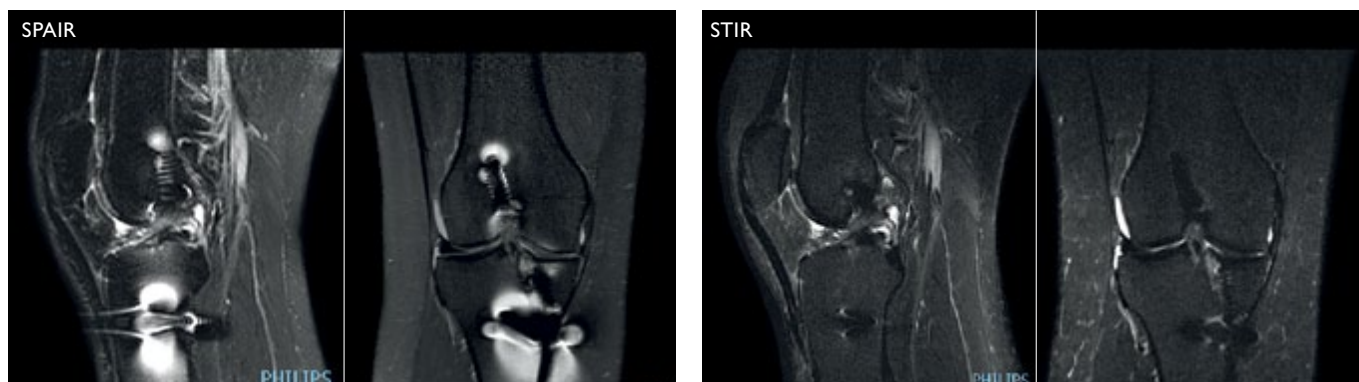


Achieve 1.5T with 32-channel SENSE Cardiac coil.
PDW TSE with asymmetric profile order, ES 6 ms, TSE factor 20, WFS 0.5,
voxels $0.8 \times 1.0 \times 2.0$ mm, no SENSE, no CLEAR, NSA 3, scan time 4:54 min.

TIP 7

Use STIR, no spectral fat saturation

Use STIR for fat suppression. This is implemented in the MARS ExamCards on NetForum, fitting the scan in one package for 1.5T or two packages for 3.0T. Do not use spectral fat saturation such as SPIR or SPAIR, because these techniques perform best in a homogeneous magnetic field.

**TIP 8**

Gradient echo images

Sometimes, gradient echo (FFE or TFE) may be needed and cannot be replaced by TSE. Note that in such cases principles as outlined in the previous tips still apply.

NetForum

www.philips.com/netforum

1.5T and 3.0T MARS [ExamCards](#) for hip and knee will soon be available for download from NetForum.

View additional information:

www.revisemri.com/blog/2011/metal-artefact-reduction/

Disclaimer

Metal implants are a contraindication for MRI, unless the MR compatibility for the implant is stated by the implant manufacturer. MR healthcare professionals are advised to contact the respective implant manufacturer in order to obtain the latest safety information to ensure patient safety relative to the use of an MR procedure.