

3T MRI Protocol for MS study - Preferred

(NOTE: Please follow the sequence order)

Head					
(Center at the orbital ridge)					
Sequence Order	#1	#2	#3/16	#14	#15
	3D SWI	3D FLAIR	MPRAGE Pre/ Post Gad	3D VIBE Post Gad - Sagittal	CSF FLOW
Sequence	gre	tse_vfl	tfl	fl3d_vibe	fl_fq_retro
Orientation	Axial	Sagittal	Axial	Sagittal	Axial
TR (ms)	29	6000	1680	3.97	83.35
TE (ms)	20	397	2.98	1.43	9.13
TI (ms)		2200	900		
FA (degree)	15		9	25	20
FOV (mm ²)	256x192	256x256	256x256	352x275	160x160
Matrix size	512x256	256x256	512x256	384x384	256x256
Nz/TH (mm)	128/2	160/1	192/1	256/0.9	1/5
Voxel size (mm ³)	0.5x1x2	1x1x1	0.5x1x1	0.9x0.9x0.9	0.6x0.6x5
Ave./Meas.	1	1	1	1	1
Phase oversmpl					30%
Slice oversmpl					
Dist. factor	20%	0%	0%	20%	20%
Phase Enc. Dir	R>>L	A>>P	R>>L	A>>P	R>>L
iPAT	2/24	2/24	2/24	2/24	
BW (Hz/pixel)	120	781	180	690	195
Flow Comp	Yes	No	No		No
Phase partial Fourier	Off	Allowed	Off	6/8	Off
Slice partial Fourier	Off	7/8	Off	6/8	
Flow Mode/Direction					Single Dir./ Through Plane
Venc. (cm/s)					10
1 st Signal/Mode					Pulse/Retro
Echo spacing (ms)		3.32	7.6		
Turbo factor		141			
Echo trains per slice		1			
Coils	Head+Neck	Head+Neck	Head+Neck	Head+Neck + SP1,2	Head+Neck + SP1
Time	06:39	5:20	3:54x2	1:45	2:05
Total Time	06:39	11:59	19:47	21:22	23:27

Note:

- These are standard conventional MRI sequences for the MS protocol. Your local standard MS protocol may differ.
- Position the subject at the orbital ridge.
- Slice position for the above sequences (SWI, MPRAGE) should be parallel to the sub-callosal plane.
- 3D FLAIR and 3D VIBE POST GAD should be acquired in a sagittal plane.
- For CSF FLOW sequence, position the slice slab at the base of the skull.

Neck (straight sinus/ jugulars) - Preferred (Center at the chin)						
Sequence Order	#4	#5	#6	#7	#8	#9
	2D MRV (neck) *	Flow Quantification (straight sinus & jugulars - Axial)**	3D VIBE Pre Gad - Sagittal	3D MRV (Dynamic) Inject Contrast after 1st measurement for the 3D MRV	3D VIBE Post Gad - Sagittal	Flow Quantification (jugulars – coronal)***
Sequence	fl_tof	fl_fq_retro	fl3d_vibe	fl3d_ce	fl3d_vibe	fl_fq_retro
Orientation	Axial	Axial	Sagittal	Coronal	Sagittal	Coronal
TR (ms)	29	42.15	3.97	3.41	3.97	36
TE (ms)	5.02	4.14	1.43	1.27	1.43	3.11
FA (degree)	60	25	25	20	25	15
FOV (mm ²)	320x256	256x256	352x275	340x255	352x275	350x350
Matrix size	512x256	448x448	384x384	384x384	384x384	448x448
Nz/TH (mm)	128/3	1/4	256/0.9	96/0.9	256/0.9	3/4
Voxel size (mm ³)	0.6x1.3x3	0.57x0.57x4	0.9x0.9x0.9	0.9x0.9x0.9	0.9x0.9x0.9	0.78x0.78x4
Ave./Meas.	1	1	1	1/15	1	1
Phase oversmpl						
Slice oversmpl				8.3%		
Dist. factor	-25.0%	20%	20%	20%	20%	20%
Phase Enc. Dir	A>>P	A>>P	A>>P	R>>L	A>>P	R>>L
iPAT	2/24	2/24	2/24	3/24	2/24	2/24
BW (Hz/pixel)	217	531	690	590	690	531
Flow Comp	Yes	No		Yes		No
Phase partial Fourier			6/8	6/8	6/8	
Slice partial Fourier			6/8	6/8	6/8	
Special Sat.	Tracking F					
Pre Saturation	Gap10mm; TH 40mm					
Flow Mode / Direction		Single Dir./ Through Plane				Free/ F>>H
Venc. (cm/s)		50				50
1 st Signal/Mode		Pulse/Retro				Pulse/Retro
Coils	Head+Neck +SP1,2	Head+Nec k+SP1,2	Head+Neck +SP1,2	Head+Neck +SP1,2	Head+Neck +SP1,2	Head+Neck +SP1,2
Time	6:57	1:21 (x3)**	1:45	4:18	1:45	4:03
Total Time	6:57	11:00	12:45	17:03	18:48	22:51

Note:

- * Position the subject to the chin for the neck. Make sure to use HEA;HEP;NE1,2;SP1,2 coils are highlighted.
- ** Please put a pulse trigger on the patient's index finger.
- ** Flow quantification will be done perpendicular to the straight sinus, the internal jugular veins (IJV's) at the upper and lower level, also coronal to get both IJV's in the neck, which leads to a total of 6 flow quantifications (three slices are collected coronally at the same time). Please use venc of 50cm/s for all venc sequences.
- ** For flow quantification at lower level, position the slice at the confluence of the jugulars.
- *** Position the coronal slice slab parallel to the jugulars. To do this, please use a MIPed sagittal slice from the time resolved 3D coronal data and use transverse slice in the lower neck and again in the higher neck to make sure you have covered the base of each jugular and the upper part of each jugular. This way you will be able to obtain a true coronal of IJV's.

Azygus - Preferred (Center at the mid sternum) †				
Sequence Order	#10	#11	#12	#13
	3D VIBE - Coronal	2D MRV (azygus) ††	2D MRV (Para Coronal to azygus arch) †††	Flow Quantification (Azygus) ††††
Sequence	fl3d_vibe	fl_tof	fl_tof	fl_fq_retro
Orientation	Coronal	Axial	Para Coronal	Axial
TR (ms)	5.41	36	45	42.15
TE (ms)	1.76	5.02	5.02	4.14
FA (degree)	25	60	60	25
FOV (mm ²)	500x390	256x256	320x240	256x256
Matrix size	384x300	512x256	512x256	448x448
Nz/TH (mm)	128/0.9	128/3	32/3	1/4
Voxel size (mm ³)	1.3x1.3x0.9	0.5x1x3	0.6x1.3x3	0.57x0.57x4
Ave./Meas.	1	1	1	1
Phase oversmpl		20%		
Slice oversmpl				
Dist. factor	20%	-33.0%	-33.0%	20%
Phase Enc. Dir	A>>P	R>>L	R>>L	A>>P
iPAT	2/24	2/24	2/24	2/24
BW (Hz/pixel)	350	217	217	531
Flow Comp		Yes	Yes	No
Sat Region 1	6/8	86 mm – Anterior	86 mm – Anterior	
Sat Region 2	6/8		86 mm – Superior	
Special Sat.		Parallel H		
Pre Saturation		Gap10mm; TH 50mm		
Flow Mode / Direction				Single Dir./ Through Plane
Venc. (cm/s)				40
1 st Signal/Mode				Pulse/Retro
Coils	Neck +SP1,2,3,4	Neck +SP1,2,3,4	Neck +SP1,2,3,4	Neck+SP1,2,3,4
Time	2:22	13:00	2:41	3:59 (x2)
Total Time	2:22	15:22	18:03	26:01

Note:

† This is an option if you have time.

†† Position the subject center to the mid sternum. Make sure to use NE1,2;SP1,2,3,4 coils.

††† Position the slice slab para coronal to the arch of the azygus vein.

†††† Flow quantification will be done perpendicular to the azygus vein at the upper and lower level. Please use venc of 40cm/s.

Now re-center at the brain for the post gad images to run the sequences #3, #14, 15 and #16 from page#1.