Episurf MRI Protocol Knee Epioscopy

Siemens 1.5T and 3T

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1. Introduction

The Episurf MRI Protocol Knee for Siemens MRI machines consists of six (or seven) MRI sequences. These include one 3D sequence and five (or six) 2D sequences:

Number	Type	Orientation	Pulse sequence
1	3D	Sagittal	SPACE
2	2D	Traversal/Axial	Tra TSE PD FS
3	2D	Sagittal	Sag TSE PD
4	2D	Sagittal	Sag TSE PD FS
5	2D	Coronal	Cor TSE PD FS
6	2D	Coronal	Cor TSE T2 FS
7 (optional)	2D	Sagittal	Sag TSE T2 FS

The settings for all these sequences are described in detail in the following text.

2. Protocol installation

2.1 Settings, 3D-sequence

Find a protocol to start from in

- SIEMENS – knee – clinical libraries – cartilage + OA

Choose the SPACE sequence in this list and make sure the settings are according to the table below.

Overview of 3D-sequence settings:

Tab	Setting	Value 1.5 T	Value 3 T
Program	Pulse sequence	3D SPACE	3D SPACE
Routine	Slabs	1	1
	Orientation	Sagittal	Sagittal
	Phase encode direction	A >> P	A >> P
	Slices per slab	≈ 140 (capture whole knee joint)	≈ 140 (capture whole knee joint)
	FOV-read (mm), Feet-Head	*≈ 160**	*≈ 160**
	FOV-phase (%), Ant-Post	*≈90** (Avoid folding artefacts)	*≈90** (Avoid folding artefacts)
	Slice thickness (mm)	0.5	0.5
	Averages	1	1
	Concatenations	1	1
Contrast	TE (ms)	45	30
	TR (ms)	1000	1000
	Flip Angle (deg)	100-120	100-120
	Fat supper.	None	None
Resolution	Voxel size (mm)	0.5x0.5x0.5	0.5x0.5x0.5
	Base resolution	320	320
	Interpolation	OFF	OFF
	Slice resolution	50%	50%
	PAT mode	GRAPPA *(located in **iPAT** sub tab)*	GRAPPA *(located in **iPAT** sub tab)*
	Distortion correction	Enabled 2D + 3D *(located in **Filter Image** sub tab)*	Enabled 2D + 3D *(located in **Filter Image** sub tab)*
Sequence	Bandwidth (Hz/Px)	≈ 350	≈ 390
	Turbo factor	30	60

2.2 Settings, 2D-sequences

The following 2D-sequences are required:

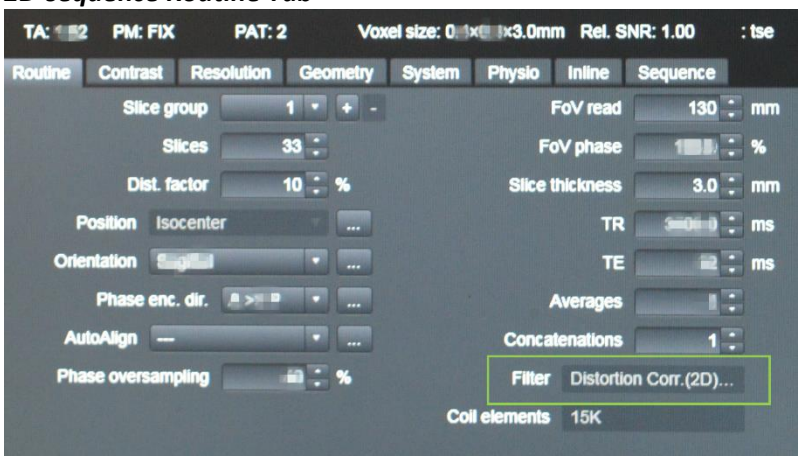
Number	Orientation	Pulse sequence
1	Traversal / Axial	TSE PD FS
2	Sagittal	TSE PD
3	Sagittal	TSE PD FS
4	Coronal	TSE PD FS
5	Coronal	TSE T2 FS
6 (optional)	Sagittal	TSE T2 FS

Sagittal T2 FS (number 6) is only required if the patient has previously undergone a meniscal surgery.

Parameter settings common for all the 2D sequences:

Tab	Setting	Value
Routine	Filter	Distortion corr. 2D
Resolution	FoV read	≈*130** (Capture whole knee joint)
	Base resolution	>= 2.5x***Fov read***. (E.g. ***FoV read***=130 → ***Base resolution***>=320)
	Slice thickness (mm)	3.0
Geometry	Slices	33* (Capture whole knee joint)
	Dist. Factor (%)	10

2D-sequence Routine Tab



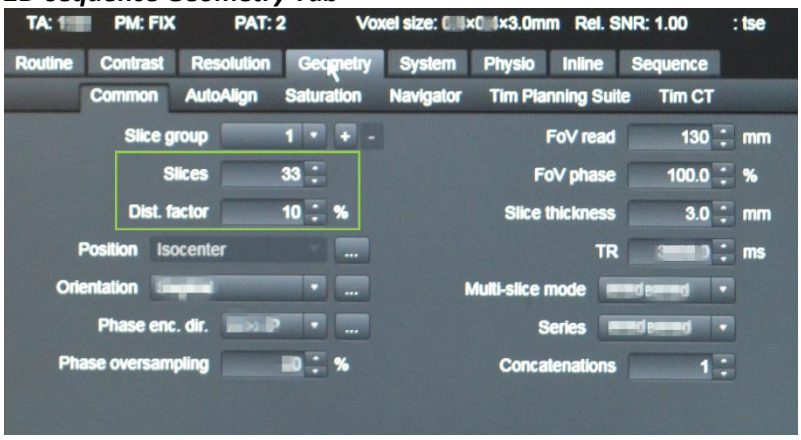
*Make sure that **Distortion correction** (2D) is applied on all sequences.*

2D-sequence Resolution Tab

*Set **Slice Thickness** to 3.0 mm.*
*Adjust **FoV read** so that the Field of view covers the whole femoral bone and articulating cartilage.*
*Set **Base resolution** to a value greater than 2.5 the **FoV read** value. This is to achieve a pixel size smaller than 0.4x0.4 mm.*
Example:
*For a **Fov read** of 130, the **Base resolution** shall be 320 or greater.*

Accepted Reconstructed Voxel size 2D-Sequences	
Min	**Max**
Use as small pixel size as possible with regards to image quality and scanning time.	0.4x0.4x3.0 mm

2D-sequence Geometry Tab



*Set **Dist. Factor** to 10%.*
*Select enough **Slices** so that the Field of view covers the whole femoral bone and articulating cartilage.*

3. Image acquisition

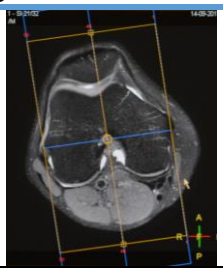
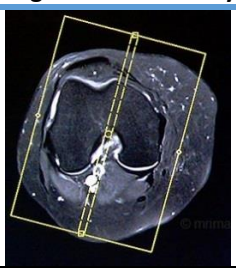
Procedure

Important	Comment
Use a knee coil.	
Place the knee as close as possible to the epicenter of the main coil.	This is to minimize geometrical distortions.
Patient must not move during and between scans.	
The protocol consists of one (1) 3D-sequence and five (5) 2D-sequences, thus six (6) sequences in total.	All sequences must have a field of view (FOV) that covers the whole knee joint.
One additional 2D sequence (Sag T2 FS) should be scanned if the patient has previously undergone a meniscal surgery	
The required voxel size for the 3D sequence is 0.5x0.5x0.5 mm.	The 3D sequence is used to create a 3D representation of the knee. The voxel resolution is very important for this process.
Folding artefacts must not interfere with the articulating cartilage.	Folding artefacts are usually not a problem as long as they do not interfere with the articulating cartilage.
Parameter settings common for all the 2D sequences are listed to the right.	**Slice thickness** = 3.0 mm. **Dist. Factor** = 10% **Pixel size** as small as possible, but not larger than 0.4x0.4mm (square pixels).
Use accelerating techniques (ex GRAPPA) as long as the image qualityis maintained.	

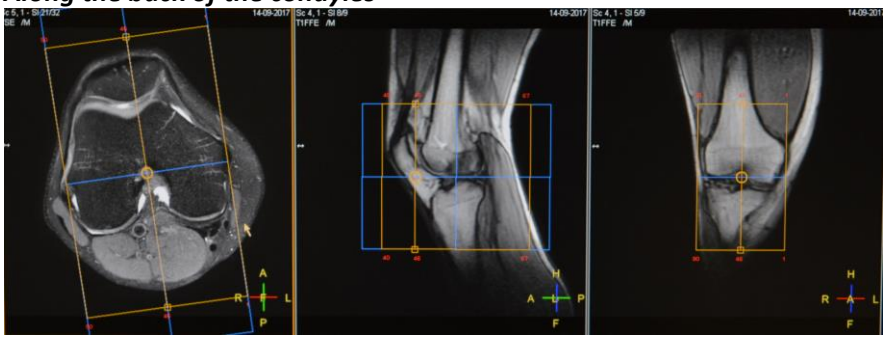
3.1 Field of View (FOV)

Make sure that the FOV fully covers the bones and articulating cartilage. This applies to all sequences.

The sagittal sequences shall be oriented either along the back of the condyles or along the lateral condyle, as specified in the table below:

Along the back of the condyles	Along the lateral condyle
	
Sag 3D SPACE	Sag TSE PD
Sag TSE PD FS	
Sag TSE T2 FS (optional sequence)	

Along the back of the condyles



Along the lateral condyle

3.2 Voxel size example

The voxel size can be found above the settings panel when a sequence is selected. The numbers are by default truncated to one decimal. By placing the mouse pointer over the Voxel size label, the values are shown with two decimals. See example in the image below.

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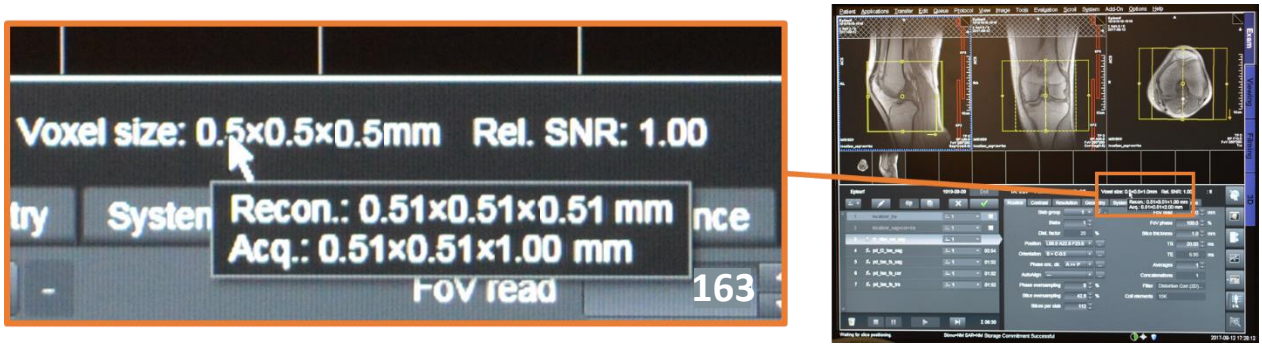

The first two numbers are the ***pixel size*** followed by the ***slice thickness***. In the example above the reconstructed pixel size is 0.51x51 mm and the slice thickness is 0.51 mm.
The pixel size if given by the following formula: $Pixel\ size = \frac{FoV\ read}{Base\ resolution}$. In the example above, ***FoV read***=163 mm and Base resolution=320 which yields the pixel size: $\frac{163}{320} = 0.509 \approx 0.51$.
For patients with a large knee the ***FoV read*** value needs to be increased to make the FOV cover the whole knee. If so, the base resolution might have to be adjusted as well to ensure correct pixel size. Required voxel sizes are listed in the table below.

Sequence	Required voxel size	Note
3D-sequence	0.5x0.5x0.5	Pixel sizes between 0.45x0.45 to 0.55x0.55 mm will be accepted (square pixels).
2D-sequences	0.4x0.4x3.0 (maximum)	Use as small pixel size as possible with regards to image quality and scanning time. A voxel size of 0.4x0.4x3.0 mm is the maximum voxel size that will be accepted.

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4. Examples of MR images acquired according to this protocol

Number	Type	Orientation	Pulse sequence / weighting
1	3D	Sagittal, along the back of the condyles	SPACE
2	2D	Transversal / Axial	TSE PD FS
3	2D	Sagittal, along the lateral condyle	TSE PD
4	2D	Sagittal, along the back of the condyles	TSE PD FS
5	2D	Coronal	TSE PD FS
6	2D	Coronal	TSE T2 FS
Optional	2D	Sagittal, along the back of the condyles	TSE T2 FS