Signature™ Personalized Patient Care*

Knee MRI Scanning Protocol
Version 3.0
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Introduction

The knee MRI scanning protocol consists of four imaging sequences (excluding localizers). The high resolution knee is scanned in a dedicated extremity coil or a flex coil and landmarked at the apex of the patella. The low resolution knee, ankle and hip (scanned in that specific order) are scanned with the inherent body coil and landmarked at the apex of the patella. Do not allow the patient to move, and do not re-landmark between the three low resolution scans.

Hitachi and Philips scanners may scan the high resolution knee, low resolution ankle and low resolution hip without removing the coil or allowing the patient to move.

Important Note: MRI scan quality can directly affect guide manufacture and accuracy. Please ensure that all protocol steps are closely followed for optimum scan quality.
Knee Scan

General Scan Requirements

• All scanners are eligible to be certified if the knee, ankle and hip can be scanned without being localized at each joint space and the coordinates being reset
• For obese patients, additional approval will be required for a larger coil
• Name the protocol “Biomet Signature Protocol”
• Do not allow the patient to move between scans
• All slices are taken parallel or perpendicular to the scanning couch
  – This means TRUE axial and sagittal slices – No oblique acquisitions including localizers
• Scan high resolution sagittal knee, low resolution sagittal knee, low resolution axial ankle and low resolution axial hip of the same side (in this order)
• If an existing implant is located in opposite knee, position the knees as far apart as possible
• Figure 1 highlights the minimum scanning volume required for each scan

Figure 1 — Extend coverage of all three areas.

Required Coils

• Inherent body coil
• Transmit-receive knee coil/phased array/flex coil
  – Phased array and flex coils should be positioned so all seams are posterior
Patient Preparation

- Thoroughly review surgical history for any metal hardware, including screws and staples†
- Offer restroom facilities to minimize discomfort during the scan

High Resolution Knee Scan

- Position the patient on the table so the affected side is as close to ISOCENTER as possible
- Place the coil on the knee
  - Use a dedicated knee coil whenever possible
  - Position the apex of the patella to the center of the coil

  **Note:** Good signal is needed 100 mm above the knee joint and 100 mm below the knee joint including visualization of the tibial tuberosity.

- **Landmark at the center of the coil**
- Scan knee localizers in true orthogonal planes
- Include SHIM
- Scan the knee using a SAGITTAL 3D T1 SPOILED GRADIENT sequence with fat saturation or water excitation (Refer Table 1 & 2 for manufacturer specific parameters)
  - Slice thickness must be 1 mm (scan at 2 mm thickness and interpolate to 1 mm if possible)
  - Acquisition matrix is 256 x 256 with a reconstructed matrix of 512 x 512
  - Bandwidth machine-specific
  - Field of View (FOV) 20–25 cm or 200–250 mm
  - Phase FOV 80–100 percent Phase Direction AP
  - Do not use partial fourier, parallel imaging or filters unless indicated in Table 1
  - One concatenation
  - TR should be T1 weighted
  - TE should be in-phase
  - Flip angle is scanner specific

- Remove coil

†If metal hardware is within 150 mm of knee joint, CT Scanning Protocol is recommended.
Table 1 — Scanner-specific Parameters 1.5T (See page 3 for Slice Thickness and Matrix)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Flip Angle 1.5T</th>
<th>Bandwidth 1.5T</th>
<th>TR/TE 1.5T**</th>
<th>Sequence***</th>
<th>Manufacturer-specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>12</td>
<td>19.23</td>
<td>Non-select/ Min Full</td>
<td>3D T1 VASC TOF FSPGR FAT SAT</td>
<td>No zoom gradient</td>
</tr>
<tr>
<td>Hitachi</td>
<td>20</td>
<td>30</td>
<td>30/8</td>
<td>3D RSSG</td>
<td>1.2T</td>
</tr>
<tr>
<td>Philips</td>
<td>20</td>
<td>Non-select</td>
<td>20/8</td>
<td>3D WATS C (cartilage)</td>
<td>–</td>
</tr>
<tr>
<td>Siemens</td>
<td>10</td>
<td>130</td>
<td>20/(varies with software version)</td>
<td>3D T1 VIBE WE (water excitation) Normal gradient mode</td>
<td>- 2D distortion correction on all scans (or large FOV filter) - slab-select excitation mode</td>
</tr>
<tr>
<td>Toshiba</td>
<td>10</td>
<td>Non-select</td>
<td>20/5</td>
<td>FE3D FAT SAT Strong</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 2 — Scanner-specific Parameters 3.0T (See page 3 for Slice Thickness and Matrix)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Flip Angle 3.0T</th>
<th>Bandwidth 3.0T</th>
<th>TR/TE 3.01T**</th>
<th>Sequence***</th>
<th>Manufacturer-specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>Manufacturer Recommended (25–40)</td>
<td>Min 61</td>
<td>&lt;10/in-phase</td>
<td>3D T1 FAST VASCULAR TOF (FSPGR) WITH FAT SAT</td>
<td>No zoom gradient</td>
</tr>
<tr>
<td>Philips</td>
<td>Manufacturer Recommended (25–40)</td>
<td>Non-select</td>
<td>&lt;10/in-phase</td>
<td>3D WATS C (cartilage)</td>
<td>–</td>
</tr>
<tr>
<td>Siemens</td>
<td>Manufacturer Recommended (25–40)</td>
<td>Min 260</td>
<td>&lt;10/in-phase</td>
<td>3D T1 VIBE WE (water excitation) Normal gradient mode</td>
<td>- 2D distortion correction on all scans (or large FOV filter) - slab-select excitation mode</td>
</tr>
<tr>
<td>Toshiba</td>
<td>Manufacturer Recommended (25–40)</td>
<td>Non-select</td>
<td>&lt;10/in-phase</td>
<td>FE3D FAT SAT Strong</td>
<td>–</td>
</tr>
</tbody>
</table>

** TRs and TEs are approximate values (All TE values should be an In-phase)
*** Scanner-specific 3D T1 Spoiled Gradient Sequence with Fat Saturation or Water Excitation
Low Resolution Knee, Ankle and Hip Scans

- Scan knee, ankle and hip (in this order)
- Patient’s leg will be moved when removing coil
  - At this point it is acceptable for the patient to readjust their position
- Landmark at the apex of the patella, reminding the patient they cannot move until completion of all remaining scans
- Scan knee localizers
- Include SHIM
- Scan the knee using same SAGITTAL 3D T1 SPOILED GRADIENT sequence with fat saturation or water excitation (Reference Tables 1 & 2 for manufacturer specific parameters)
  - Slice thickness 4–6 mm
  - Acquisition matrix is 256 x 256 without reconstruction of 512 x 512
  - Bandwidth machine-specific
  - FOV 26 cm or 260 mm
  - Phase FOV 80–100 percent Phase Direction AP
  - Do not use partial fourier, parallel imaging or filters of any kind unless indicated
  - One concatenation
  - TR should be T1 weighted
  - TE should be in-phase
  - Flip angle is scanner specific

Figure 3
Low Resolution Scans

Ankle Scan

- Move ankle to the center of the bore by inputting inferior offset (ex I400)
- Acquire ankle localizer with true orthogonal planes
- Scan axial T1 ankle from above the malleoli to the mid-calcaneus (Figure 4)
  - 5 mm thickness x 2 mm gap
  - FOV 260 mm
  - 1 average/NEX/NSA
  - 1 concatenation
- This may require a TR in the PD weighted range

Note: Bilateral ankles may be scanned, if preferred, however, do not increase FOV

Figure 4

Hip Scan

- Move hip to center of the bore by inputting superior offset (ex S400)
- Acquire hip localizer with true orthogonal planes
- Scan axial T1 hip from anterior superior iliac spine to pubic symphysis
  - 5 mm thickness x 2 mm gap
  - FOV 360
  - 1 average/NEX/NSA

Note: Bilateral hips may be scanned, if preferred, however, do not increase FOV

Figure 5
Frequently Asked Questions

1. The patient has a hip replacement or an ankle screw in the surgical side. Can I still scan with an MRI?
   
   Yes. Increase the bandwidth or use a metal reduction sequence. Any implanted metal should be 150 mm from the knee joint for the MRI to be successful.

2. The contralateral knee has been replaced. What do I do?
   
   Position the knee as far away from the surgical side as possible. If there is still distortion, the patient may need to be scanned with SIGNATURE CT.

3. Does the ankle need to be dorsiflexed?
   
   No. However, the ankle should be as AP as possible. There should not be external or internal rotation greater than 30 degrees. It is critical that the patient does not move. If necessary, restraint, sandbags and other immobilization devices are recommended.

4. Can I use more than one concatenation on any scan?
   
   No. One package or slab is preferred. It is acceptable for the TR of the ankle or hip to be greater than 800 when necessary to guarantee one slab.

5. What parameters can I change?
   
   Do not change FOV, matrix, slice thickness or sequence type. TR and TE may vary depending on software. Slice number will vary depending on patient size.
Please use the following criteria to evaluate scan quality prior to allowing the patient to move.

☐ Did you use the approved test scan protocol?
☐ Were all localizers and scans true axial or sagittal to the table (not anatomical)?
☐ Did you only reference once?
☐ Was the entire knee included in the scan (typically between 80–120 slices)?
☐ Was fat saturation and/or water excitation selected?
☐ Were motion artifacts detected? If so, a re-scan is required.
☐ Were metal artifacts present in the hip or ankle joints? If so, use maximum bandwidth for that scan while also capturing the contralateral joint.
☐ Are there metal artifacts within 150 mm of the tibial plateau? If so, please contact Signature™ system scan support at the number listed on page 1.
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