MRI Protocols of the ESSR Arthritis Subcommittee

MRI Protocols

- Ankle
- Anterior Chest Wall in Arthritis
- Cervical Spine in Rheumatoid Arthritis
- Elbow
- Foot
- Hand and Wrist
- Hip
- Knee
- Sacroiliac Joints
- Shoulder
- Spine in Spondyloarthritis
- Temporomandibular Joint
- Whole Body MRI for Chronic Recurrent Multifocal Osteomyelitis
Ankle

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with feet first
- Dedicated coil
- Foot close to neutral position, avoiding any plantar or dorsiflexion
Axial plane: 90° alignment to the tibia

Sagittal plane: 90° alignment to the intermalleolar axis; the skin surrounding the hindfoot has to be included

Coronal plane: aligned to the intermalleolar axis
Recommended sequences

Sag PD FS

Cor PD FS

Ax PD FS

Ax T1
# MRI protocol

<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
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<td>10-20</td>
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</tbody>
</table>

*if optimal assessment of synovitis/osteitis is needed*
Anterior Chest Wall in Arthritis

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in prone or supine position
- Surface coil
- Coil size depends on the examined area: whole sterno-costo-clavicular region or sterno-clavicular joints
Localizers whole sterno-costo-clavicular region

Coronal slices  Sagittal slices  Axial slices
Localizers sterno-clavicular joint

Coronal slices

Axial slices
Recommended sequences whole sterno-costo-clavicular region
Recommended sequences sterno-clavicular joint

Cor PD FS

Ax PD FS
### MRI protocol whole sterno-costo-clavicular region

<table>
<thead>
<tr>
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<td>Cor STIR</td>
<td>300</td>
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<td>2200-2600</td>
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<td>320</td>
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<td>Sag or Ax T2</td>
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<td>3</td>
<td>2400-2800</td>
<td>65-85</td>
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# MRI protocol sterno-clavicular joint

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<td>400</td>
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<tr>
<td>T1 FS</td>
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<td>10-20</td>
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<td>CE T1 FS*</td>
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<td>3</td>
<td>500-700</td>
<td>10-20</td>
<td>400</td>
</tr>
</tbody>
</table>

*if optimal assessment of synovitis/osteitis is needed
Cervical Spine in Rheumatoid Arthritis

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient positioning: Head first supine
- Coils: Head and neck
- Immobilize the head with cushions
Localizer

Axial plane: cover the entire cervical spine

Sagittal plane: from the right to the left transverse process

Coronal plane: cover the entire vertebral column
Recommended sequences

Sag T1

Sag STIR
Recommended sequences

Ax T2 FS

Cor T1
Recommended sequences

Ax T1 FS CE
### MRI protocol

<table>
<thead>
<tr>
<th>Recommended Sequences#</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
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<tbody>
<tr>
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<td>280</td>
<td>3</td>
<td>4500</td>
<td>92</td>
<td>288x512</td>
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<tr>
<td>Sag STIR</td>
<td>300</td>
<td>3</td>
<td>3500</td>
<td>70</td>
<td>224x320</td>
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<tr>
<td>Ax T1</td>
<td>240</td>
<td>3</td>
<td>649</td>
<td>10</td>
<td>288x384</td>
</tr>
<tr>
<td>Ax T2 FS(^a)</td>
<td>160</td>
<td>3</td>
<td>568</td>
<td>19</td>
<td>224x320</td>
</tr>
<tr>
<td>Sag CE T1 FS(^*)</td>
<td>300</td>
<td>3</td>
<td>600</td>
<td>11</td>
<td>224x320</td>
</tr>
<tr>
<td>Ax CE T1 FS(^*)</td>
<td>240</td>
<td>3</td>
<td>700</td>
<td>10</td>
<td>288x384</td>
</tr>
</tbody>
</table>

#Coronal T1 in cases with atlantoaxial and/or atlanto-occipital changes suggesting lateral or rotatory subluxation

\(^a\)Axial T2 FS of the atlantoaxial, atlanto-occipital and, when needed, subaxial region

\(^*\)Postcontrast sagittal and axial T1 (FS) for clear delineation of active inflammation
Elbow

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

Patient positioning
(depending on the habitus and range of motion)

• supine position with flex coil
• prone (Superman position) with knee or flex coil
Localizer

Coronal plane: cover the entire joint from the anterior to the posterior skin surface

Sagittal plane: cover the entire joint from the medial to the lateral side

Axial plane: from two slices above the olecranon fossa to two slices below the radial tuberosity
Recommended Sequences

Cor T1

Cor PD FS
(or STIR/TIRM or T2 FS)
Recommended Sequences

Sag PD FS

Ax PD FS
(or STIR/TIRM or T2 FS)
Optional Sequences

Sag T1 FS CE
# MRI protocol

<table>
<thead>
<tr>
<th>Recommended Sequences&lt;sup&gt;1&lt;/sup&gt;</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
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</thead>
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<td>72</td>
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<td>2000</td>
<td>61</td>
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<tr>
<td>CE T1 FS*</td>
<td>160x160</td>
<td>2.5</td>
<td>400</td>
<td>15</td>
<td>384x384</td>
</tr>
</tbody>
</table>

<sup>1</sup>Modified parameters should be applied with T2 FS and STIR/TIRM

*if optimal assessment of synovitis/osteitis is needed
Foot

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with feet first
- Foot in slight (10 degree) plantar flexion
- Surface coil
- Adequate immobilisation (padding)
Axial plane: perpendicular to the metatarsal and phalanges bones. Cover the foot from the tip of the toe to the tarsal bones.

Coronal plane: parallel to the metatarsal and phalanges bones. Cover the foot from the dorsal to the plantar surface.

Sagittal plane: parallel to the metatarsal and phalanges bones. Cover the foot from side to side.
Recommended sequences

Ax PD FS (or STIR/TIRM or T2 FS)

Cor PD FS (or STIR or TIRM or T2 FS)

Ax T1

Sag PD FS
## MRI protocols

<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (cm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
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<tbody>
<tr>
<td>Sag PD FS</td>
<td>8-10</td>
<td>3</td>
<td>3500</td>
<td>40</td>
<td>288x384</td>
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<tr>
<td>Ax STIR or T2 FS or PD FS</td>
<td>8-10</td>
<td>3</td>
<td>1800</td>
<td>25</td>
<td>192x256</td>
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<tr>
<td>Ax T1</td>
<td>8-10</td>
<td>3</td>
<td>400</td>
<td>15</td>
<td>288x380</td>
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<tr>
<td>Cor T2 FS or STIR or PD FS</td>
<td>8-10</td>
<td>3</td>
<td>3000</td>
<td>110</td>
<td>256x220</td>
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</table>
Hand and Wrist

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient head first, prone with arm up (e.g., Superman position)
- Wrist/hand at the centre of the bore to ensure field homogeneity
- Coils: dedicated wrist/hand coil
- Immobilisation: tape hand to maintain position
Localizer wrist

**Axial plane**: from 3-4 cm proximal to the radiocarpal joint to 2 cm distal to the carpometacarpal joint

**Coronal plane**: skin to skin traversing the joint anteriorly to posteriorly to include the same field of view as the axial images

**Sagittal plane**: skin to skin perpendicular to the coronal
Localizer Hand

**Axial plane:** from 2 cm proximal to the most proximal joint to 2 cm distally to the most distal joint of interest

**Coronal plane:** skin to skin traversing the joint anteriorly to posteriorly to include the same field of view as the axial images

**Sagittal plane:** skin to skin perpendicular to the coronal plane, to include the same field of view as the axial images
**Recommended sequences - Wrist**

- **Cor STIR** (or TIRM or T2 FS)
- **Cor T1w**
- **Ax T1w**
- **Ax PD FS** (or STIR/TIRM or T2 FS)
- **CE T1 FS Ax**
Recommended sequences - Hand

- Cor STIR (or TIRM or T2 FS)
- Cor T1w
- CE T1 FS Cor
- Sag STIR (or TIRM or T2 FS)
- Ax T1w
- CE T1 FS Ax
<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (cm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
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<tr>
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<td>3/3D#</td>
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<td>25</td>
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<td>15</td>
<td>320x240</td>
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<td>3/3D#</td>
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<td>320x240/320x450</td>
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<td>400</td>
<td>15</td>
<td>320x240/320x450</td>
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<td>3/3D#</td>
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<td>40</td>
<td>320x240/320x450</td>
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<td>8-10</td>
<td>3/3D#</td>
<td>400</td>
<td>15</td>
<td>320x240/320x450</td>
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</tbody>
</table>

#3D sequences are performed to allow the evaluation of small (< 3mm) and/or oblique structures

*if optimal assessment of synovitis/osteitis is needed
Hip

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with the feet first
- Hips in 15º internal rotation
- Coils: large flexible
- Immobilisation: Tape toes to maintain position
Pelvis coronal plane: large FOV (i.e., 30-40 cm) from the sacroiliac joints to the pubic symphysis

Hip axial plane: anterior iliac spine through lesser trochanter

Hip coronal plane: skin to skin traversing anteriorly to posteriorly the acetabular columns to include the entire bony pelvis and tendon insertions

Hip sagittal plane: medial acetabular wall through greater trochanter
Recommended sequences: pelvis

Coronal STIR
(or T2 FS)
Recommended sequences: Hip

Ax PD FS (or STIR or T2 FS)

Cor T1

Ax T1

Cor PD FS (or STIR or T2 FS)
**MRI protocol**

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<tr>
<th>Recommended Sequences</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
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<td>25</td>
<td>320X240</td>
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<td>300</td>
<td>5/3D</td>
<td>1800</td>
<td>25</td>
<td>320X240</td>
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<tr>
<td>Hip Cor T1</td>
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<td>5/3D</td>
<td>400</td>
<td>15</td>
<td>320X240</td>
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<td>5/3D</td>
<td>2000</td>
<td>15</td>
<td>320X240/384x268</td>
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<td>5/3D</td>
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<td>15</td>
<td>320X240/384x268</td>
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<tr>
<td>Hip CE T1 FS*</td>
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<td>5/3D</td>
<td>400</td>
<td>15</td>
<td>320X240/384x268</td>
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</tbody>
</table>

*if optimal assessment of synovitis/osteitis is needed*
Knee

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with feet first
- Knee coil
- Immobilise the knee with cushions
- Three-plane localizer
Localizers

Axial plane: parallel to the knee joint line

Sagittal plane: parallel to the medial facet of lateral condyle

Coronal plane: parallel to posterior facets of the femoral condyles
Recommended Sequences

Sag PD FS

Ax PD FS

Cor PD FS

Cor T1 (or Sag T1)
Recommended Sequences

Sag T1 FS CE
## MRI protocol

<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
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<th>TE (ms)</th>
<th>Matrix</th>
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<td>3</td>
<td>3570</td>
<td>39</td>
<td>288x384</td>
</tr>
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<td>13</td>
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<td>3</td>
<td>470</td>
<td>13</td>
<td>358x512</td>
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</tbody>
</table>

*if optimal assessment of synovitis/osteitis is needed
Shoulder

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position
- Shoulder coil
- The arm alongside and parallel to the body in neutral to slight external rotation
- Coronal oblique images parallel to the supraspinatus tendon
- Glenohumeral and acromioclavicular joints are included
Localizer

Axial plane: from the acromioclavicular joint to two slices below the inferior glenohumeral ligament

Sagittal plane: from the deltoid muscle to two slices medial to the glenoid

Coronal plane: from the anterior margin of the coracoid process to two slices posterior to the humeral head
Recommended sequences

Ax PD FS

Cor T1

Cor T2 FS

Sag T2
Recommended sequences

CE axial T1 FS

CE cor T1 FS
### MRI protocol

<table>
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<th>Ax PD FS</th>
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<td>450-650</td>
<td>10-20</td>
<td>300 x 250</td>
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<td>10-20</td>
<td>300 x 250</td>
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<td>3000</td>
<td>30</td>
<td>300 x 250</td>
</tr>
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</table>

*if optimal assessment of synovitis/osteitis is needed*
Sacroiliac Joints

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with the feet first
- Spine coil or body phased array coil
**Oblique coronal plane:** parallel to the long axis of the sacrum - tangent to the posterior surface of S2

**Oblique axial plane:** perpendicular to the coronal orientation
Recommended sequences

- Obl cor T1
- Obl cor T1FS
- Obl axial STIR
- Obl cor T2 FS or STIR or TIRM or PD FS
Recommended sequences

CE Obl ax T1 FS

CE Obl cor T1 FS
<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (cm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
</tr>
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<tbody>
<tr>
<td>Obl cor T1</td>
<td>24-30</td>
<td>3 (max 4)</td>
<td>400-700</td>
<td>8-20</td>
<td>&gt;350</td>
</tr>
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<td>Obl cor T1 FS</td>
<td>24-30</td>
<td>3 (max 4)</td>
<td>400-700</td>
<td>8-20</td>
<td>&gt;350</td>
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<tr>
<td>Obl cor T2 fat sat</td>
<td>24-30</td>
<td>3 (max 4)</td>
<td>4000-6000</td>
<td>60-90</td>
<td>&gt;350</td>
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<td>3 (max 4)</td>
<td>3000-6000</td>
<td>60-90</td>
<td>&gt;350</td>
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<tr>
<td>Obl axial STIR</td>
<td>20-25</td>
<td>3 (max 4)</td>
<td>3000-6000</td>
<td>60-90</td>
<td>&gt;350</td>
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<tr>
<td>CE Obl cor T1 FS</td>
<td>24-30</td>
<td>3 (max 4)</td>
<td>400-700</td>
<td>8-20</td>
<td>&gt;350</td>
</tr>
<tr>
<td>CE Obl axial T1FS</td>
<td>20-25</td>
<td>3 (max 4)</td>
<td>400-700</td>
<td>8-20</td>
<td>&gt;350</td>
</tr>
</tbody>
</table>
Spine in Spondyloarthritis

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position
- Spine coil
- Two plane localizer
  - Frontal
  - Sagittal
- Lumbar and thoracic spine are mandatory, preferably the whole spine should be examined
Localizer
Recommended sequences

- Sag T1: Midline, Lateral
- Sag STIR: Midline, Lateral
Recommended sequences

Midline

Lateral

Sag T1

Midline

Sag STIR

Lateral
Optional sequence

„Scout“ / Planning Ax T2
### MRI Protocol

| Field-of-view:                          | Adjusted for the spine, optimizing the examined area  
|                                         | Mandatory sagittal images: For the whole spine  
|                                         | 2 or 3 spinal blocks with overlap to be fused, depending on the scanner  
|                                         | Optional axial T2: FOV adjusted to the area of interest, 20-32 cm  
| Slice thickness:                        | 3 mm preferable (maximal 4 mm)  
| Interslice distance (gap)               | 10%  |
## MRI Protocol

<table>
<thead>
<tr>
<th>Recommended sequences</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>TI (ms)</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sag T1</td>
<td>510-550</td>
<td>8-20</td>
<td>-</td>
<td>424 x 300</td>
</tr>
<tr>
<td>Sag STIR</td>
<td>2500-6000</td>
<td>70-100</td>
<td>150 (1.5T) 180-220 (3T)</td>
<td>424 x 300</td>
</tr>
<tr>
<td>Ax T2 (optional)</td>
<td>2200-5000</td>
<td>90-120</td>
<td>-</td>
<td>320 x 166</td>
</tr>
</tbody>
</table>
Temporomandibular Joint

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with the head first
- Head coil
**Localizer: Inflammatory disease**

**Axial plane:** refer to the sagittal plane, orient the scan parallel to the hard palate and cover the entire TMJ from the corpus callosum up to the angle of the jaw.
If the head is tilted, the angulation has to be adjusted on the coronal plane.

**Sagittal plane:** refer to the axial plane, orient the scan perpendicular to the condyle of the mandible (i.e., of the same side that has to be examined). Check the correct positioning on the other two planes.
If the head is tilted, the angulation has to be adjusted on the coronal plane.

**Coronal plane:** refer to the axial plane, orient the scan parallel to the condyle of the mandible (i.e., of the same side that has to be examined). Check the correct positioning on the sagittal plane.
Recommended Sequences: Inflammatory disease

- Cor T1 (or Ax T1)
- Ax T2 FS (or STIR or TIRM)
- Cor T2 FS (or STIR or TIRM)
- Cor T2
Localizer:
Joint derangement

*Sagittal oblique:*
- refer to the axial plane
- orient the scan perpendicular to the condyle of the mandible (i.e., of the same side)
- check the correct positioning on the other two planes
- the number of slices has to cover the joint from side to side

The MR scan has to be performed:
- with the mouth opened and closed
- on the right and on the left TMJ
Recommended Sequences:
Joint derangement

Sag oblique PD FS mouth closed
Sag oblique PD FS mouth opened
Recommended Sequences:
Joint derangement

Sag oblique PD mouth closed

Sag oblique PD mouth opened
<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cor T1</td>
<td>230</td>
<td>3</td>
<td>420-620</td>
<td>10</td>
<td>256x256</td>
</tr>
<tr>
<td>Ax T2</td>
<td>230</td>
<td>5</td>
<td>2500-5500</td>
<td>90</td>
<td>256x256</td>
</tr>
<tr>
<td>Cor T2 FS</td>
<td>230</td>
<td>3</td>
<td>2500-5000</td>
<td>100</td>
<td>256x256</td>
</tr>
<tr>
<td>Cor T2</td>
<td>230</td>
<td>3</td>
<td>2200-3200</td>
<td>100</td>
<td>256x256</td>
</tr>
<tr>
<td>CE T1 FS</td>
<td>140</td>
<td>2.5</td>
<td>420-620</td>
<td>10</td>
<td>256x256</td>
</tr>
<tr>
<td>(for synovitis and/or osteitis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD FS oblique mouth closed &amp; opened</td>
<td>140</td>
<td>2.5</td>
<td>2200-3200</td>
<td>24</td>
<td>256x256</td>
</tr>
<tr>
<td>PD oblique mouth closed &amp; opened</td>
<td>140</td>
<td>2.5</td>
<td>2200-3200</td>
<td>24</td>
<td>256x256</td>
</tr>
</tbody>
</table>
Whole Body MRI for Chronic Recurrent Multifocal Osteomyelitis

MRI Protocols of the ESSR Arthritis Subcommittee

MRI scan

- Patient in supine position with the head first
- Hands either under the pelvis (preferred for immobilisation) or over the abdomen
- Elbows often outside the field of view
- Multiple coils – to ensure coverage
- Coil coverage: Head to feet
- 3-5 stations depending on age and height of the patient
Recommended sequences

T1

STIR

TIRM
## MRI protocol

<table>
<thead>
<tr>
<th>Recommended Sequences</th>
<th>FOV (mm)</th>
<th>Slice thickness (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>550</td>
<td>3</td>
<td>300-600</td>
<td>8</td>
<td>640x640</td>
</tr>
<tr>
<td>STIR</td>
<td>550</td>
<td>3</td>
<td>3000-4000</td>
<td>70</td>
<td>512x512</td>
</tr>
<tr>
<td>TIRM</td>
<td>550</td>
<td>2</td>
<td>4000-6120</td>
<td>60</td>
<td>512 x 512</td>
</tr>
</tbody>
</table>
Ax = axial
CE = contrast enhanced
Cor = coronal
CRMO = Chronic Recurrent Multifocal Osteomyelitis
FOV = field of view
FS = fat suppressed
Obl = Oblique
PD = proton density
Sag = sagittal
STIR = short tau inversion recovery
TE = echo time (ms)
TIRM = turbo inversion recovery magnitude
TMJ = Temporomandibular joint
TR = repetition time (ms)
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