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MRI SCAN PROTOCOL
HUMERUS

Important Information

This MRI scanning protocol consists of a localizer and a detailed sagittal scan of both humerus bones (surgical and contralateral side). This protocol is for scanners with 1.5 Tesla or higher. The MRI scan quality (with clear bony edges and details) is critical to the production of accurate patient-specific surgical instruments. **Deviations from this protocol may result in an unusable scan and delay of surgery.** Please contact Materialise's support team if you require further clarification.

General Scan Requirements

- Thoroughly review surgical history for any **implants**, including screws, staples or other small metal hardware. If an existing implant is located in the opposite extremity, position the arm as far apart as possible. If metal is present in the (contralateral) hip region, the MRI scan needs to be evaluated to ensure all critical points for planning and guide design are definable.
- Remove any non-fixed **metal** prosthesis, jewelry, zippers that might interfere with the scan region. The patient should be dressed in hospital gown or scrubs.
- Position the patient 'head first supine'; make the patient comfortable (provide cushions if needed/possible) and instruct him/her it's critical not to move during the whole procedure. If **any movement** is detected the patient will need to be rescanned as this will prevent the accurate development of the patient-specific model.
- Position the patient on the table so the affected/scanned side is as close to the **isocenter** as possible. Use a dedicated coil whenever possible (torso or abdominal coil); place it over the upper arm (from shoulder to elbow). Securely tighten the body coil using straps to prevent respiratory artifacts.

Scanning Instructions

- Center the laser beam localiser over the mid humerus; landmark at the center point of the coil.
- For elbow corrections, include the proximal radius and ulna in the field of view.
- First scan the surgical side and then the contralateral side by using the same parameters; movement of the patient in between scans to position more in isocenter is allowed.

Scanning Parameters

- **Localizer: three planes, including whole humerus; from above humeral head till below the elbow joint. Plan the sagittal slices in the axial plane and check the positioning block in the other two planes. Slices must be sufficient to cover whole bony regions of upper arm.**
- **Sagittal 3D T1 spoiled gradient with Fat Saturation (Fat Sat) or Water Excitation (WE) of the surgical side AND the contralateral side separately.**

MRI acquisition type	3D
Helical	Just above the tibio-talar joint through to the carpal-metacarpal joints.
Collimation	Slice thickness: 2 mm interpolated to 1 mm (* if no interpolation possible, scan with 1 mm slice thickness)
Number of scan averages (NEX/NSA):	1-2
FAT SAT	FAT SAT on (no classic or special)
Gradient mode	whole
Phase encoding direction	A>>P, ROW to avoid wrap-around artefact from abdomen
Phase FOV	50-100 %
SHIM	Include SHIM
Settings	-Do not use partial fourier, parallel imaging or filters -Adding saturation bands over the chest will help to reduce breathing artefacts -TR should be T1 weighted -TE should be (shortest) in-phase -3D distortion correction when possible
Field of View (FOV)	from the acromioclavicular joint to below the elbow joint (max. 320mm)
Acquisition matrix	512x512 (if possible 256x256 interpolated to 512x512)

Scanners

Scanner	Sequence	Manufacturer-specific	Magnetic Field Strength 1,5T				Magnetic Field Strength 3,0T			
			TR	TE	Flip angle	Bandwidth	TR	TE	Flip angle	Bandwidth
GE	3D T1 Vasc FSPGR Fat Sat	No Zoom Gradient	20	4-10	10-20	19,23	< 10	in phase	25	Min 61
Siemens	3D T1 Vibe WE	3D distortion correction	18-25	4-9,2	10-25	130	< 10	in phase	130	Min 260
Philips	3D Wats C		20	8	10-25	Non-select	< 10	in phase	Non-select	Non-select
Toshiba	FE3D Fat Sat Strong		15-40	5	10-25	Non-select	< 10	in phase	Non-select	Non-select
Hitachi	3D RSSG	1,2T	30	4-10	20-30	30	N/A	N/A	30	N/A

** TR and TE are approximate values. All TE values should be in-phase

Reconstruction and Delivery of the Images

- **No** secondary reconstructions; images must be scanned at the given parameters or more strict.
- **No** reformatting into coronal or axial planes; **no** MPR's. **No** 3D reconstructions.

Very Important

- Provide the complete data set of **original DICOM images** to the surgeon.
- **Lossy compression is not allowed** (ISO_10918_1, ISO_14495_1, ISO_15444_1 or ISO_13818_1)
- **Only send the images needed for our procedure.** Do not send any recons, reformats, viewer software, etc.
- Retain a permanent archive (PACS) copy of the RAW data of images (as scanned by the original parameters and in the uncompressed format)

Data anonymisation

- Do not erase patient name and ID – Ensure necessary rights are obtained for transfer of data to Materialise.
- Data will be anonymized by Materialise on receipt of the data, after cross-check with prescription of the surgeon to ensure the images of the right patient are provided.

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