

Akron Radiology Inc. Technique Manual For MRI

Including Gadolinium Advisory Statement

Version 2022b

Summa Health System
CCOC

Western Reserve Hospital

Affiliated Imaging Centers: Green, Hudson, White Pond, Medina

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Gadolinium Advisory Statement – ARI

Gadolinium contrast material has been found to be associated with the condition Nonspecific Systemic Fibrosis (NSF). The following recommendations are suggested by Akron Radiology Inc. based on the American College of Radiology Guidelines:

Group II Agents (Gadavist, Multihance, Dotarem or Prohance)

As of 2017, when utilizing group II agents, based on the most recent scientific and clinical evidence the ACR Committee on Drugs and Contrast Media considers the risk of NSF among patients exposed to standard or lower than standard doses of group II GBCAs low or possibly nonexistent. Therefore, assessment of renal function with a questionnaire or laboratory testing is optional prior to intravenous administration. As in all instances, group II gadolinium agents should only be administered if they are deemed necessary by the supervising radiologist, and the lowest dose needed for diagnosis should be used as deemed necessary by the supervising radiologist.¹

While the ACR Committee also states that the risk for NSF is extremely low regardless of renal function or dialysis status, in patients with end-stage renal failure on dialysis, we recommend avoiding the use of any gadolinium agent unless medically necessary. If gadolinium is given, then the agent should be administered just prior to dialysis.

Group I or III Agents (Magnevist, Optimark, Omniscan or Eovist)

When Group I or III agents MUST be used, patients over age 60 OR with risk factors for renal disease (i.e., dialysis, renal transplant, single kidney, kidney surgery, kidney cancer, diabetes or hypertension requiring medical therapy) are required to have their serum creatinine level measured before the contrast-enhanced MR examination.

GFR > 60: Acceptable to use Group I or III gadolinium agent.

GFR > 30: Acceptable to use Group I or III gadolinium agent if clinically necessary.

GFR <30: The usage of Group I or III gadolinium agent is considered contraindicated.

All deviations from the accepted guidelines are to be approved by the attending Radiologist.

References:

1. ACR Manual on Contrast Media. Version 10.3 May 2017
2. Incidence of Nephrogenic Systemic Fibrosis after Adoption of Restrictive Gadolinium-based
3. Contrast Agent Guidelines. Radiology July 2011 260:105-111.

NEUROLOGIC IMAGING:

BRAIN (ROUTINE) Note: Flow compensation is in use for precontrast T(1)

Sagittal	T(1) SE
Axial	FLAIR
	T(2) FSE
	Diffusion
	Susceptibility/BOLD/GRE
Coronal	T(2) FSE

BRAIN (R/O TUMOR including METS, Infection **or** Ordered with Contrast)

Routine Brain as above (EXCEPT DELETE CORONAL T(2) SE) but add:

Axial T(1) SE

Post Gad:

Axial T(1) SE

Coronal T(1) SE

Sagittal T(1) SE (if tumor present)

If for “encephalocele” (not “encephalopathy”), add 3D high resolution T2 in area of concern

BRAIN (KNOWN TUMOR)

Routine Brain as above (EXCEPT DELETE CORONAL T(1) SE) but add:

Axial T(1) SE

Post Gad:

Volumetric 3D T1 (MPRAGE) obtained at 1 mm in the axial (or sagittal) plane and reconstructed in the other two remaining planes

BRAIN (MS)

Axial	DWI
	T2
	3D FLAIR (2D axial + sag when 3D unavailable)
	T2 GRE
	T1 Pre

Post Gad: (5 minute delay)

Axial 3D T1 MPRAGE (axial and sagittal if 3D unavailable)

SEIZURE TREATMENT PLANNING (Dr. ROSSI)

Axial	GRE
	FLAIR

	T2 SPACE	- may not be available at offsites
	DWI	
Coronal	T1 MPRAGE pre	
	T2 SE	- Thin slices
	FLAIR	- thin slices
	T2 SPACE	- may not be available at offsites
Sagittal	FLAIR	
	T1 MPRAGE pre	- not needed at offsites
	T2 SPACE	- may not be available at offsites
Post-contrast	Coronal T1 MPRAGE post	
DTI when available		- may not be available at offsites

BRAIN (REFRACTORY SEIZURES <70 y.o.) – non-Rossi protocol

Sagittal	T(1) SE
Axial	FLAIR
	T(2) FSE
	GRE
	Diffusion
Coronal	T(1) 3D GE
	T(2) FSE
	FLAIR
Post Gad: (Only if requested by referring physician):	
Axial	T(1) SE
Coronal	T(1) SE

BRAIN (STROKE)

Routine Brain

Only if specified add:

Intracranial MRA

Neck MRA

Only if specified: Perfusion: Power inject 20cc of Gad w/ 2sec delay. Radiologist will choose level.

BRAIN (AVM)

Routine Brain

Intracranial MRA

Intracranial MRV

BRAIN (ANEURYSM)

Routine Brain

Intracranial MRA

BRAIN CSF Flow Study

Indications: NPH, Chiari malformation, aqueductal stenosis, posterior fossa mass/cyst, endoscopic 3rd ventriculostomy

Axial	DWI (sb1000)
	3D T1 MPRAGE
	T2
	FLAIR
Sag	T2 (2 mm slice thickness)
CSF Flow	2D FLASH (venc setting to 10 cm/sec, unless NPH then 20 cm/sec)

Brain for Traumatic brain injury

Indications: Subacute traumatic brain injury with new or worsening symptoms or delayed recovery

Axial	DWI (sb1000)
	T2
	3D susceptibility weighted imaging (axial T2 GRE if SWI unavailable)
	3D FLAIR
	3D T1 MPRAGE

INTERNAL AUDITORY CANALS (Bell's Palsy (7th nerve), Trigeminal (5th nerve) Neuralgia)

Whole Brain:

Axial	T(2) SE
	FLAIR
	Diffusion

Pre Gad: (through area of interest)

Axial	T(1) SE FatSat
	3D T(2) GRE (CISS)

Post Gad: (through area of interest)

Axial	T(1) SE FatSat
Coronal	T(1) SE

Whole Brain:

Axial	T(1) SE
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Localize examination for area of concern:

IAC – Internal Auditory Canals
 7th nerve – Slightly lower than for IAC
 5th nerve - Brainstem

PITUITARY

Whole Brain:

Axial	T(2) FSE
	FLAIR

Pre Gad: (through pituitary)

Coronal	thin T(1) SE
Sagittal	thin T(1) SE
Post Gad:	90sec Coronal
Coronal	thin T(1) SE (dynamic post-bolus)
Sagittal	thin T(1) SE

CERVICAL SPINE ROUTINE

FOV – Skull base through T1-2	
Sagittal	T(1) SE
	T(2) FSE
	STIR
Axial	T(2) Spoiled GE
	T(2) FSE

CERVICAL SPINE (SYRINX)

FOV – Skull base through T1-2	
Sagittal	T(1) SE
	T(2) FSE
Axial	T(1) SE
	T(2) Spoiled GE

CERVICAL SPINE (Post Op)

Routine Cervical Spine without Gad

CERVICAL SPINE (Tumor, Infection or whenever Gad is requested)

FOV – Skull base through T1-2

Pre Gad:

Routine Cervical Spine

Sagittal	Diffusion (add if possible if infection suspected)
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Post Gad:

Axial	Fat-saturated* T(1) SE through entire spine
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Sagittal	Fat-saturated* T(1) SE
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* No fat-saturation for 1) Demyelinating disease / Multiple sclerosis or 2) If inadequate image quality from metallic hardware

THORACIC SPINE

Sagittal	T(1) SE
	T(2) FSE
	STIR
Axial	T(1) through entire spine
	T(2) GRE through entire spine

THORACIC SPINE (Tumor, Infection or whenever Gad is requested)

Pre Gad:

Routine Thoracic Spine

Sagittal Diffusion (add if possible if infection suspected)

Post Gad:

Axial Fat-saturated* T(1) SE

Sagittal Fat-saturated* T(1) SE

* No fat-saturation for 1) Demyelinating disease / Multiple sclerosis or 2) If inadequate image quality from metallic hardware

LUMBAR SPINE

FOV -

Sagittal FOV: T11-12 through upper sacrum
T(1) SE
T(2) FSE
STIR

Axial FOV: T12-S1
T(1) SE
T(2) FSE – angled blocks through disc spaces (2-3 blocks only)
T(2) FSE – straight- ONLY if entire canal was not included in angled blocks

If scoliosis present add:

Coronal T(1) SE

LUMBAR SPINE (POST OP or whenever gadolinium contrast is requested)

FOV – T11-12 through upper sacrum

Post Op – Scan Pre & Post Gad T(1) Axials over entire spine

Pre-Gad:

Sagittal T(1) SE

Sagittal T(2) FSE

Sagittal STIR

Sagittal Diffusion (add if possible if infection suspected)

Axial T(1) SE - angled blocks through spine (2-3 blocks only), stitched together
T(2) SE - angled blocks through spine (2-3 blocks only), stitched together

Post Gad:

Axial Fat-saturated* T(1) SE

Sagittal Fat-saturated* T(1) SE

* No fat-saturation for 1) Demyelinating disease / Multiple sclerosis or 2) If inadequate image quality from metallic hardware

SPINE (CSF FLOW)

Use pulse gating

Axial: 2D Phase Contrast, flow compensation

Sagittal: 2D Phase Contrast, flow compensation

ENTIRE SPINE SURVEY (CORD COMPRESSION, INFECTION, TUMOR, METS)

Perform in TWO SETS of Sagittal acquisitions (Use body coil if tall patient):

1. Total C spine and upper T spine
2. Lower T spine and total L spine

Sagittal	T(1) SE
	T(2) FSE
	STIR
Axial	T(2)

If ordered with Gad or if abnormal findings present:

Sagittal post	T(1) SE
Axial post	T(1) SE straight sequence only with angles to discs through area of interest

ORBITS

Brain: Cover entire orbit from brainstem forward.

Axial	T(2) SE
	FLAIR
	Diffusion

Orbits:

Pre Gad:

Axial	T(1) SE
Coronal	T(1) SE FatSat
	T(2) FSE FatSat
	STIR

Post Gad:

Coronal	T(1) SE FatSat
Axial	T(1) SE FatSat

Axial	T(1) SE Whole brain (optional)
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NECK

Pre Gad:

Sagittal	T(1) SE
Axial	T(1) SE
Axial	T(2) FSE FatSat
Coronal	T(2) FSE FatSat

Post Gad:

Axial	T(1) SE FatSat
Coronal	T(1) SE FatSat

TMJ

Sagittal	T(2) FSE (Bilateral, Closed position only)
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		MRI
Coronal	Proton Density FatSat (Bilateral, Open & Closed positions) T(1) SE	

Musculoskeletal Imaging

KNEE

Sagittal	PD FatSat	(DO NOT ANGLE SAGITTAL IMAGES)
	PD	
	T(2)	
Axial	PD FatSat	
Coronal	PD FatSat	
	T(1) SE	

If structural problem related to patella include:

Axial T(2) FSE

KNEE (ARTHROGRAM)

Post Injection:

Coronal	T(1) FatSat
	T(2) FSE FatSat
Sagittal	T(1) FatSat
	T(2) FSE FatSat

SHOULDER

Coronal	T(1) FSE
	PD FatSat
	T(2) FSE
Sagittal	T(1) FSE
	T(2) FatSat
Axial	PD FatSat

If r/o labral pathology include:

Axial T(1) SE

Set up coronal and sagittal off of axial at glenohumeral joint

Sagittal = parallel to joint

Coronal = perpendicular to joint

SHOULDER (ARTHROGRAM)

Post Injection:

Coronal	T(1) FatSat
	T(2) FatSat
Coronal	T(1) FatSat with arm raised above head (ABER)
Sagittal	T(1) FatSat
	T(1) SE
Axial	T(1) FatSat

BRACHIAL PLEXUS

Large FOV bilateral:

Axial	T(1) SE
Coronal	T(1) SE
	T(2) FatSat
Sagittal C-spine	T(2)

Small FOV unilateral of affected side:

Axial	T(2) FatSat
Sagittal	T(2) FatSat

PECTORALIS MAJOR

Use shoulder coil low across chest/upper arm.

Small FOV (upper chest from humeral neck to mid shaft for pectoralis insertion):

Axial	STIR
	T(1) SE

Moderate FOV (plane of pectoralis tendon as seen from axials):

Coronal	T(1) SE
	PD FatSat

Moderate FOV (plane perpendicular to coronal):

Sagittal	T(1) SE
	T(2) FatSat

WRIST

Plain films needed for baseline

Coronal	PD FatSat
	T(2) FatSat
	T(1) SE
Axial	PD (through AOI and perpendicular to joint space)
	T(2) FatSat
Sagittal	T(2) FatSat (through AOI)

Patient is positioned head first with the fingers straight out.

Smallest FOV possible – Cover distal 2–3 cm of radius/ulna through CMC joints.

WRIST (ARTHROGRAM)

Post Injection:

Axial	T(1) FatSat
Sagittal	T(1) FatSat
Coronal	T(1) SE
	T(1) FatSat
	T(2) FatSat

HAND

Coronal	T(1) SE PD FatSat T(2) FatSat
Sagittal	T(2) FatSat

High Resolution:

Axial	PD (high resolution) T(2) FatSat (high resolution)
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HAND (ARTHRITIS)

Screening for inflammatory arthritis of both hands and wrists.

FOV to include distal radioulnar joint through MCPS of both hands.

Pre Gad:

Coronal	T(1) SE PD FatSat T(2) FatSat
Axial	PD T(2) FatSat
Sagittal	T(2) FatSat

Post Gad:

Axial	T(1) FatSat
Coronal	T(1) FatSat

DIGIT

Axial	PD T(2) FatSat
Coronal	T(1) SE T(2) FatSat
Sagittal	PD (high resolution) T(2) FatSat

When scanning thumb, planes need to be done **in the plane of the thumb**

HIPS

Need plain films for baseline

Except for Sagittals study is of **both** hips (body coil) regardless of what is requested.

Axials to include **entire** pelvis.

Bilateral:

Coronal	T(1) SE STIR
Axial	T(2) FatSat T(1) SE

Unilateral:

(affected side only, small FOV, centered on joint space)

Sagittal	PD FatSat
Coronal	T(2) FatSat
Axial Oblique	PD FatSat (angled to neck)

HIP (ARTHROGRAM)

Post injection:

Axial	T(1) SE FatSat (axial oblique) T(2) FatSat
Coronal	T(1) SE T(1) SE FatSat T(2) FatSat
Sagittal	T(1) SE FatSat

Use flex coil on affected hip with small FOV.

PELVIS (BONY)

Routine Hips (to cover entire pelvis through SI joints on coronals and through iliac bone on axials).

Sagittal	PD FatSat
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QUADRICEPS MUSCLE (THIGH)

Both sides with large FOV:

Coronal	T(1) SE T(2) FatSat
Axial	T(1) SE T(2) FatSat

Affected side only with small FOV:

Sagittal	T(2) FatSat
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ADDUCTOR DETACHMENT (ATHLETIC HERNIA/PUBALGIA)

Large FOV of pelvis:

Coronal	T(1) SE
	T(2) FatSat
Axial	T(2) FatSat

Small FOV centered over pubic bone:

Axial Oblique – 90 degrees to long axis of symphysis as seen on sagittal.

Axial Oblique PD

	T(2) FatSat
Sagittal	T(2) FatSat (through symphysis)
Sagittal	T(2) FatSat (through affected hip)

SACROILIAC JOINTS (all with contrast unless contraindicated)

Plain films are desired for baseline

FOV centered on sacrum and SI joints

Coronal oblique (parallel to long axis of sacrum)

T(1) FSE
T(1) Fat Sat
T(2) Fat Sat

Axial oblique (perpendicular to coronal plane scan)

T(1) FSE
T(2) FatSat

Post-Gad T(1) Fat Sat in both planes as above

SACRUM

Axial	T(1) SE
	T(2) FSE
Coronal	T(1) SE
	T(2) FatSat
Sagittal	T(2) SE

LUMBOSACRAL PLEXUS

Axial	T(1) SE
	T(2) FSE
Cor oblique	T(1) FatSat
	STIR
Post-Gad	
Axial	T(1) SE
Cor oblique	T(1) FatSat

EXTREMITY MASS

Required: conventional radiographs and skin marker on all cases.

Skin marker above & below lesion, not directly over lesion.

Inject Gad on all tumor cases regardless of region.

Pre Gad:

Axial	T(2) SE	(obtain first - most important!)
	T(1) SE	
	T(1) FatSat	
	T(2) FatSat	

In plane where the pathology is best seen

T(1) SE
T(2) FatSat

Post Gad:

Axial	T(1) FatSat
Same 2nd plane as pre gad	
	T(1) FatSat

EXTREMITY INFECTION

Pre Gad

Axial	T(1) SE
	T(2) FatSat

In plane where pathology is best seen

T(1) SE
T(2) FatSat

Remaining plane

T(1) SE (when imaging small joints)
T(2) FatSat

Post Gad:

Axial	T(1) FatSat
Same 2nd plane as pre gad	
	T(1) SE FatSat

THIGH (OTHER THAN FOR MASS)

Large FOV bilateral thighs

Coronal	T(1)
Coronal	T(2) FatSat or STIR
Axial	T(2) FatSat or STIR

Small FOV unilateral side of symptoms

Coronal	T(1)
Coronal	T(2) FatSat or STIR
Axial	T(1)
Axial	T(2) FatSat or STIR
Sagittal	T(2) FatSat or STIR

LEG (OTHER THAN FOR MASS)

Large FOV bilateral legs

	Coronal	T(1)
Coronal		T(2) FatSat or STIR
Axial		T(2) FatSat or STIR

Small FOV unilateral side of symptoms

Coronal	T(1)
Coronal	T(2) FatSat or STIR
Axial	T(1)
Axial	T(2) FatSat or STIR
Sagittal	T(2) FatSat or STIR

ANKLE/FOOT

Plain films are required if exam is for bone abnormality.

Hindfoot is same as ankle, forefoot is midfoot forward.

Foot-axial is long axis, Ankle-axial is short axis.

Sagittal	T(1) SE
	T(2) FatSat
Coronal	T(1) SE
	PD
Axial	T(2) FatSat
	T(2) FatSat
	PD

FOOT (NEUROMA)

Routine Ankle/Foot

Drop - Coronal PD

Add:

Pre Gad:

Coronal	T(1) FatSat
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Post Gad:

Coronal	T(1) FatSat
Sagittal	T(1) FatSat

FOOT (INFECTION)

Axial is long axis, Coronal is short axis

Sagittal	T(1) SE
	T(2) FatSat
Coronal	T(1) SE
	T(2) FatSat
Axial	T(1) SE
	T(2) FatSat

Post Gad:

Sagittal	T(1) FatSat
Coronal	T(1) FatSat

ELBOW

Axial	PD T(2) FatSat
Sagittal	T(2) FatSat
Coronal	T(1) SE PD FatSat T(2) FatSat

Set coronals and sagittals off of axial acquisition. Use epicondyles to set slices.
Always include bicipital tuberosity.

ELBOW (ARTHROGRAM)

Post Injection:

Axial	T(1) FatSat
Coronal	T(1) FatSat T(2) FatSat
Sagittal	T(1) FatSat

ELBOW/ARM (BICEP RUPTURE)

Axial	T(1) SE PDFS
Sagittal	T(1) SE T(2) FSE
Coronal	T(1) SE STIR

FOREARM

Axial	T(1) SE T(2) FatSat
Sagittal	PD FatSat
Coronal	T(1) SE PD FatSat

TOTAL BODY FOR MULTIPLE MYELOMA

Coronal	T(1) SE STIR
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Cover areas of interest in large field of view including as little as

1. Head/neck
2. Chest and upper abdomen/upper extremities and lower abdomen
3. Pelvis/lower extremities

Abdominal Imaging

LIVER (ROUTINE)

Axial T(1) GE (all sequences are single breath hold)
 T(2) Ultrafast SE
 IN / OUT
 Diffusion b0-50 and 800-1000
 Coronal T(2) Single Shot
 Post Gad:
 Axial T(1) GE
 Coronal T(1) GE
 Dynamic study with power injection at 0sec(arterial), immediate (venous),
 90sec, 3min, 5, 15 min

LIVER (HEMANGIOMA)

Routine Liver
 Add: Axial T(2) Ultrafast SE high (triple) TE

LIVER (FOLLOW UP)

Axial T(1) SE
 T(1) GE (all GE & Ultrafast SE sequences are single breath hold)
 T(2) Ultrafast SE
 IN / OUT
 Diffusion b0-50 and 800-1000
 Coronal T(1) GE
 STIR
 Post Gad:
 Axial T(1) GE (begin acquisition at 90sec post injection, use
 power injector)
 Coronal T(1) GE

LIVER (FATTY INFILTRATION)

Axial T(1) SE
 T(2) Ultrafast SE
 IN / OUT

LIVER (HEPATOMA, CIRRHOSIS, METS) - EOVIIST

Pre Eovist:

Axial T(1) Ultrafast Spoiled GE
 T(2) Breathhold
 IN / OUT
 Coronal T(1) GRE
 T(2) Breathhold

Post Eovist:

Axial T(1) Ultrafast Spoiled GE
 (Use bolus tracking over left ventricle)
 Dynamic study with power injection at 0sec(arterial), immediate (venous),
 90sec, 3min, 5min, 10min, & 20min.

Axial Diffusion b0-50 and 800-1000 (during delay)
 Coronal (20min T(1) Ultrafast Spoiled GE

SPLEEN

- Same as Routine Liver including 15 minute post-contrast delay
- Change FOV to cover entire spleen

BILIARY SYSTEM – MRCP

Biliary System:

Coronal T(2) Ultrafast SE (single breath hold)
 T(2) Balanced GE
 T(2) Thick Slab
 T(2) 3D restored 384 Triggered
 Axial T(2)
 T(2) FatSat
 Mult. rotation T(2) Ultrafast SE thin slice breathhold (in best angle from thick slab)
 Post processing MIPS & Source images

Liver:

Axial T(1) SE
 T(2) SE
 In/Out phase GRE
 Diffusion b0-50 and 800-1000
 Coronal T(1) SE

RENAL

Axial	In/Out phase GRE T(2) FSE T(2) FatSat
Coronal	T(1) GE single breath hold T(2) FSE STIR

Post Gad:

Axial	T(1) GE single breath hold
Coronal	T(1) GE single breath hold

Send Axial Subtraction images to PACS (Axial T1 contrast minus Axial T1 pre)

Dynamic study with power injection at 0sec(arterial), immediate (venous),
90sec, 3min, & 5min.

Axial	Diffusion b0-50 and 800-1000 (during delay)
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MR UROGRAM

250 mL normal saline IV before

Axial	In/Out T2 FSE T2 fat-sat
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20 mg IV Lasix about 15 minutes before gad

Coronal	T1 GE single breath T2 FSE STIR T2 thick slab MRCP with MIP
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Coronal 3d flash to cover kidneys ureters and bladder

Pre, 20, 100-120 sec

Axial vibe 3 minute

Coronal 5, 6, 7, 8, 9, 10 minutes

axial vibe 12

coronal 15 minutes

Make subtractions for all post-gad sequences

ADRENAL GLAND

Axial	T(1) SE T(1) FatSat T(2) In Phase / Out of Phase GE
Coronal	T(2) FSE

In Phase/ Out of Phase GE

Pancreas (ROUTINE)

Axial T(1) GE (all sequences are single breath hold)

T(2) Ultrafast SE

IN / OUT

Diffusion b0-50 and 800-1000

Coronal T(2) Single Shot

SSFP

Mult. rotation T(2) Ultrafast SE thin slice breathhold (in best angle from thick slab)

Post processing MIPS & Source images

Post Gad:

Axial T(1) GE

Coronal T(1) GE

Dynamic study with power injection at 0sec(arterial), immediate (venous),
90sec, 3min, 5

ABDOMEN – NONSPECIFIC (ABDOMINAL PAIN, OTHER)

Field of view – diaphragm through iliac crests

Axial T(1)

T(2) fat sat

IN/OUT

Coronal T(2)

MRI ENTEROGRAPHY

Prep – 4-6hr NPO

Contrast – 3 x 450ml bottles of Volumen (or Breeza) one hour prior to imaging

Optional glucagon – 1 mg IM (contraindicated in glaucoma, known pheochromocytoma or insulinoma) (Note: Onset of action 8-10 min and duration of 12-27 min)

Field of view – Coronal performed with large FOV to include entire abd/pelv

Patient position - PRONE

Pre Gad:

Coronal T(2) FatSat (Breathhold)

Steady State GE

Diffusion 0-50 and 800-1000

Axial T(2) Abdomen (Breathhold)

T(2) Pelvis (Breathhold)

Post Gad:

Coronal T(1) Multiphase 0, 30, 70 sec

Axial T(1) FatSat Abdomen

T(1) FatSat Pelvis

PELVIS (SOFT TISSUES OR BLADDER CA STAGING)

Axial	T(1) SE
	T(2)
	T(2) FatSat
Axial	Diffusion b0-50 and 800-1000
Coronal	T(2) FatSat
Sagittal	T(2) FSE

Post Gad (Bladder CA staging or if requested):

T(1) all planes with FatSat

PELVIS (ENDOMETRIOSIS)

Axial	T(1) SE Fat Sat
	T(1) no fat sat
	T(2)
	T(2) FatSat
	T2*
Coronal	T(2) FatSat
Sagittal	T(2) FSE

PELVIS (UTERINE ARTERY EMBOLIZATION)

Pre Gad:

Axial	T(1) Spoiled GE 2D FatSat
	T(2) FatSat
	T(2) SE – angled parallel to long axis of uterus
Sagittal	T(2) SE
Coronal	T(2) SE - angled perpendicular to long axis of uterus

Post Gad:

Axial	T(1) Spoiled GE 2D FatSat
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PELVIS (PELVIMETRY)

Axial	T(1) FSE
Sagittal	T(1) FSE
Oblique (inlet) Coronal	T(1) FSE

PELVIS (PLACENTA)

Axial	T(1) GE single breath hold
	T(2) TSE (Breathhold)
Sagittal	T(2) TSE (Breathhold)
Coronal	T(2) TSE (Breathhold)

RECTAL OR CERVIX (STAGING FOR TUMOR)

3T unless s/p hip arthroplasty

Note: Please make attempt to get Colonoscopy/Sigmoidoscopy report for rectal CA cases and put in PACS

Insert 120ml of ultrasound gel into rectum for rectal cancer – try to get large air bubbles out

Field of view – lower pelvis only – small field of view

Axial oblique (perpendicular to long axis of rectum at level of tumor)

T(1) (no fat sat or gad on any sequences)

T(2) FSE no fat sat

Diffusion b0-50 and 800-1000

Sagittal T(2) FSE

Coronal T(2) FSE

If with contrast, add:

Axial T1 FS pre-contrast

Axial, coronal and sagittal with fat-sat

MR Defecography – COE and Barberton only

Insert 120 mL of ultrasound gel into rectum

Locations, MAP and SHIM

Axial T1 of the pelvis (FOV of the scans should cover pubic symphysis to inferior coccyx)

AX FASE

SAG FASE

COR T2

SAG SSFP CINE (20 phases, 2 seconds long)

Rest

Squeeze (Kegel): First couple images rest, then instruct patient to squeeze for 8 seconds, rest, repeat

Strain: Same as above but instruct to strain (Valsalva) instead of squeeze

Evacuate x3: Same as above but ask patient to push gel out.

If patient cannot evacuate, add 60 mL more gel and attempt again. If unsuccessful with this, have patient go to the bathroom and re-image after gel evacuated

PROSTATE

3T unless s/p hip arthroplasty

Preference is to wait four weeks after prostate biopsy

Pre-Gad:

Axial T(1) Whole pelvis

All remaining sequences small field of view

Axial T(2) FSE

Sagittal T(2) FSE

Coronal T(2) FSE

Axial Diffusion b0-50 and 800-1000

Post-Gad:

Axial Multiphase T(1) FAT SAT

SCROTUM

Use small flex coil

Pre Gad:

Axial T(1) SE

T(2) FSE

Sagittal T(1) SE

Post Gad:

Axial T(1) SE

Sagittal T(1) SE

PENILE MRI

- Axial
 - o T2 FSE
 - o T2 FS
 - o T1 SE
 - o In phase & out of phase
 - o DWI
- Coronal
 - o T2 FSE
- Sagittal
 - o T2 TSE
 - o T2 Fat-sat
- If request with contrast
 - o Axial T1 fat-sat pre-contrast
 - o 3plane post-gad with fat-sat

ABDOMEN/PELVIS (SUSPECTED APPENDICITIS IN PREGNANCY)

MRI

Axial	T(1) T(2) SSFSE breath hold with fat sat IN/OUT
Sagittal	T(2) SSFSE breath hold
Coronal	T(2) SSFSE breath hold with wide field of view to include kidneys/GB

CHEST

Perform in prone position when attention to anterior structures

Axial	T(1) SE
Coronal	T(1) SE T(2) FSE

MRA Imaging

Note: Use of Ablavar (blood pool agent) only at discretion of interpreting radiologist. Not to be used for carotid MRA

CIRCLE OF WILLIS (HEAD OR INTRACRANIAL)

Sagittal Scout

Axial: 3D TOF MRA, combined MOTSA

CAROTID (NECK OR EXTRACRANIAL)

Pre Gad:

Axial: 2D or 3D TOF MRA of entire carotid system

Post Gad:

Axial: 3D TOF MRA (from Aortic Arch to Circle of Willis)

CAROTID (NON-CONTRAST) (NECK OR EXTRACRANIAL)

Axial: 2D or 3D TOF MRA entire carotid system

Axial: 3D TOF MRA of carotid bifurcation only

MR VENOGRAM HEAD

Pre-Gad:

Sagittal: 2D TOF MRV

Coronal: 2D TOF MRV

Post Gad: (Do not use contrast if performing MRA during same exam)
2D TOF MRV Wide FOV

RENAL ARTERIES

Coronal	T(2) Balanced GE
Axial	T(2) Balanced GE
	T(2) TSE
	T(1) Spoiled GE

Run coronal 3D subtraction & axial timing bolus sequences.

Post Gad: 3D-TOF MRA of renal arteries

RENAL ARTERIES (DONOR)

Axial	T(1) Spoiled GE
Coronal	T(1) SE
	T(2) FSE

Run breathhold no contrast mask & axial timing bolus sequences.

Post Gad:

	3D-TOF MRA of renal arteries
Coronal	T(1) SE

RENAL VEINS

Axial:	T(2) Balanced GE
Coronal:	T(2) Balanced GE

Breathhold no contrast mask

Post Gad: Timing run w/ 10sec scan delay, 5cc test bolus just above renal arteries.
3D-TOF MRA breathhold with double dose (35cc)

Add Renal Protocol post Gad if examination performed to evaluate tumor.

PORTAL VEIN

Axial	T(2) Balanced GE
Coronal	T(2) Balanced GE
Sagittal	2D TOF MRA with satbands on one side through portal vein
	2D TOF MRA with satband on <u>other</u> side through portal vein
	T(1) SE BlackBlood

Breathhold no contrast mask

Post Gad: Timing run w/ 30sec scan delay, 5ml test bolus
3D-MRA breathhold with double dose

INFERIOR VENA CAVA

Axial: T(2) Balanced GE

Coronal: T(2) Balanced GE

2-D axial MRA to cover IVC (5 slices/breathhold, MIP together)

Breathhold no contrast mask

Post Gad: Timing run w/ 30sec scan delay, 5cc test bolus
3D-MRA breathhold with double dose

THORACIC AORTA

Use Cardiac Table gating

Axial T(1) SE gated

ParaSagittal T(1) SE gated (Candy Cane)

Breathhold no contrast mask

Axial: Timing run in Aortic Arch, 2ml test bolus

Post Gad: ParaSagittal 3D MRA of Aorta

When doing parasagittals be sure to change orientation to coronal before angled

AORTIC ARCH & GREAT VESSELS

Axial: T(2) Balanced GE to include ascending and descending aorta

Post Gad: ParaSagittal CareBolus with 20ml

ABDOMINAL AORTA

Axial: T(1) Steady State GE

Coronal T(1) Steady State GE

Post Gad: Coronal 3D CareBolus with 20ml

PERIPHERAL LOWER EXTREMITY RUNOFF

Localizer from renal to ankle

Do visual prep

OR

Do timing bolus

Post Gad: Coronal 2D TOF MRA

1st phase – 2.0cc/sec for 20cc through femurs

2nd phase – 1.0cc/sec for 30cc through ankle

do scan from renal to ankle then back up from ankle to renals

CARDIAC (MYOCARDIAL VIABILITY)

Axial: T(1) Ultrafast SE black blood

CINE Balanced GE

2D TOF

Perfusion

BREAST IMAGING

BREAST (ROUTINE)

Axial T(1)
 T(2) FatSat
 T(2) FatSat

Contrast: 10ml Gadovist with 20 sec delay

Post Gad: Axial multiphase dynamic

Delayed: Sag L and R FatSat

BREAST (IMPLANTS)

Axial T(2) TIRM
 T(2) FatSat
 T(2) WaterSupressed
 T(2) TIRM FatSat
Sagittal T(2) TIRM
 T(2) FatSat
 T(2) WaterSupressed
 T(2) TIRM FatSat

Ver 7.0 Revisions

Updated Routine Brain

diffusions

Sagittal sequences

CSF flow

Updated Routine L/S with axial T(2)

Updated all MS

Knee add pd fatsat

Shoulder add t2 cor fatsat

Ankle change t1 coronal to pd fatsat

Elbow change t2 axial to fatsat

Hip change t2 axial to fatsat

Hip arthrogram no t2

Revamp forearm

Abd

added in/out phase as routine

added t2 thick slab rotations to MRCP

MRA

Peripheral lower extremity runoff

Cardiac

7.1 Revisions:

Tech update

IAC FatSat

Abd Ao

8.0 Revisions

Added Brain Bleed

Sacrum

Breast

Extremity infection

Sagittal STIR spines

Arm raised shoulder arthrogram

Updated liver to dynamic

renal with T(2) FatSat

MRCP with trigger 3D, Ultrafast SE coronal, and Liver

Dynamic pancreas

Added MRA Portal Vein

Version 9.0 Revisions

Gad Advisory Statement

Version 10.0 Revisions

New MSK protocols

PDFS in place of T(2) on almost all sequences

Rtn use of Gad for infection

Version 11.0 Revisions

Neuro update from Sept meeting

Rtn Post Gd brain in two planes

Update orbits

New MSK protocols

Quad muscle

Adductor rupture (hernia)

Forearm

Update MSK

Elbow

Ankle

Extremity mass & infection add PD FatSat, best plane

Hips

Abd update

Uterine Ablation protocol

Add pelvimetry

MRA carotid update

Version 11.1 Revisions

Neuro update from Sept meeting

Add rtn BOLD

Dynamic Sella

Add GRE to T spine

Update no gad for post op C spine

Did not: add rtn brain coronal, pre T1 axial on post gad brains, seizure MPRAGE

MSK

Update latest shoulder

Hips with small FOV unilateral and axial oblique added

New SI jnt post gad

Foot/ankle orientation change and add Neuroma & infection

Move brachial plexus to msk

Add pectoralis major

Add hand and digit

Add bony pelvis

Add calf

Version 11.3 Revisions

Neuro

Rtn brain on IAC studies
Sagittal post gad on initial pituitary
Post op lumbar T(1) over surgical levels only
Orbits to include rtn brain

MSK

Revised Athletic Pubalgia

Abd

Add Placenta
Dynamic Renal
Gad adrenals
High T(2) liver hemangioma

Version 11.4 Rev

Neuro

Add FLAIR axials to seizures
Sella T(1) post dynamic coronal
Post op lumbar entire spine – go figure

Abd

EOVIST

Version 11.5 Rev

Change:

HASTE – Ultrafast SE
THRIVE – Ultrafast Spoiled GE
TRUFI – Balanced GE
FLASH – Spoiled GE
FISP – Steady State GE

Abd

Add coronal STIR to Renal

Version 11.5b Rev

Neuro

Add Pre Gad T(1) axials to all brains
Axial MPRAGE (3D IR) to seizures
Add Cor T(2) FatSat to neck

MSK

Change pelvis to T(2) FatSat

Abd

Update dynamic timing in abd

Version 13 Rev (6/4/2013)

Neuro

All pituitary exams include dynamic post contrast imaging
Cervical spine axial FSE T(2) included on routine

Abd

Rectal MR for staging added
Liver Eovist limited to hepatoma, cirrhosis or mets
Liver Eovist – 20 min imaging includes coronal
Adrenal – post contrast imaging deleted
Add Suspected appendicitis in pregnancy protocol

Gadolinium advisory updated

Version 2013b (9/2013)

Updated numbering scheme

MSK

Proton/Spin density sequence performed at TE of 60
Changed SI joint protocol
Thighs
Legs

Abd

Diffusion weighted imaging with b value 0-50 and 800-1000 added for most abdominal sequences

Pelvic for endometriosis – T1 is now with fat sat
Rectal – angle axial perpendicular to long axis of rectum at level of tumor
Prostate

MRA

Added optional post-gad MRV head

Version 2014

Neuro

Specified field of view for Cervical and Lumbar
Add Axial GRE to Brain for seizure
Limit Brain for seizure to patients <70 yo, otherwise perform routine Brain

MSK

For Infection - SE T(1) all three planes in small joints

Abd

Updated Pelvis for UAE

Version 2015

Neuro

Updated Entire Spine Survey

MSK

Updated Foot (Infection)

MRI

Version 2015b

Neuro

Seizure protocol only for refractory seizure or specific requests for protocol
IAC – coronal T1 post Gad now performed without fat sat (ACR accreditation requirements)

Orbits - Add Pre Gad axial T1 and T2 non-fat sat orbits and coronal STIR pre contrast (ACR)

MSK

Knee – add sagittal T(2) (ACR)

Ankle/Foot – add T(1) coronal (ACR)

SI joints use Gad for all

Shoulder – add coronal T(1)

Abd

Renal – change axial T(1) to In/Out phase GRE (ACR)

Add MR Urogram

Pancreas – If cyst known or detected, then add thin slice MRCP sequence to determine if cyst communicates to pancreatic duct

MRCP now includes dynamic multiphase post Gad T(1) of liver

Enterography performed in prone position. Add optional IM glucagon

Rectal protocol changed to Rectal or Cervix for staging

Prostate – add axial T(1) whole pelvis (ACR)

Version 2015c

Neuro

Brain for seizures – remove axial 3D, add coronal T(1)

Orbits – Remove axial T(2)

Abd

MRCP back to non-contrast

Add Abdomen – nonspecific (abdominal pain, other)

Other

Updated Gadolinium advisory statement regarding patients at risk requiring creatinine determination

Version 2015d

Neuro – Brain with contrast - delete coronal T(1)

MSK

Add T(1)FatSat

MRA

MR Venogram Head – use gadolinium on all except when patient undergoing MRA during same exam

Added statement about Ablovar (blood pool agent)

Version 2016a

Neuro - L spine – axials done in blocks angled through discs, but straight can be included especially if entire canal was not included in angled blocks

Abd - Pelvis for soft tissues – post contrast sequence to be performed without fat suppression

Pelvis for rectal CA – tech please make attempt to get colonoscopy report

Breast -Updated sequences

Version 2016b

MRI Brain for seizure for patients with first seizure or 70 y.o.– perform routine brain without contrast or with/without contrast if requested

Version 2017

Add Total Body for Multiple Myeloma

Reverse policy regarding seizure as noted in 2016b

Version 2018

Updated abdomen/pelvis in pregnancy for suspected appendicitis

Version 2018b

Brain (routine) add Cor T(2)

Corrected typos in MRV Head

Brachial plexus – add cervical spine sag sequence

Add Lumbosacral plexus protocol

Version 2018c

TMJ coil no longer available. Use head coil

Prostate T1 pre and post contrast use Fat Sat (large FOV T1 is without Fat Sat)

Updated Breast MRI

Update to Gadolinium advisory statement

Version 2019

Brain for seizure – coronal changed to 3D GE T(1)

Adrenal - added coronal in/out phase GE

MR Enterography – change axial T2 to no fat sat

Carotid MRA – noncontrast can be done 2D or 3D

Version 2019b

Brain for known tumor – Change post contrast to 3D volumetric (MPRAGE)

Version 2019c

Updated Brain protocols (deleted Cor T1 from routine and Cor T2 brain with contrast)

All protocols realigned in proper columns

Version 2020a – Jan 2020

Chest for endobronchial valve

Version 2020b – May 2020

Renal MRI – send subtraction images to PACS

Rectal MRI – optional ultrasound gel usage

Pelvis with contrast – indication includes bladder CA staging

Version 2020c – August 2020 with Oct update

Neck – change axial precontrast T1 to non-fat sat

Liver – post contrast – remove 15 min delay sequence

L spine post op – Angle Axial T2 through discs

Version 2021a – April 2021

Pancreas – post-contrast series to end after 5 minutes

Kidney – post-contrast series to end after 5 minutes

Rectal cancer – 120 cc rectal gel for rectal cancer

MR Defecography – added protocol for COE and Barberton

MR hand – reminder for MR thumb to perform in plane of thumb

Post-op Lumbar spine – reminder to perform T2 angled blocks through disc spaces

Brain – add 3D high resolution T2 in area of concern if indication is “encephalocele”

Pelvis (soft tissues or bladder CA staging) – add axial T2 no fat-sat, DWI

Pelvis (endometriosis) – add axial T1 no fat-sat, axial T2 no fat-sat, axial T2*

Adrenal – add axial T2

Version 2021b – October 2021

Pancreas and **Kidney** post-contrast series to end after 5 minutes, but all **livers** go out to 15 minutes

Pituitary changed from ½ dose gad to normal dose

New **Penile MRI** protocol

Cervical cancer: clarify there is an axial T2 without FS. For gad, add axial pre-contrast T1FS + 3 planes post *with fat-saturation*

New **seizure protocol** for Dr. Rossi patients; changes to previous seizure protocol (offsites may not have all sequences including SPACE, okay to omit these unless ordered by Rossi)

Version 2022a

Liver: remove coronal T1 and STIR, add Coronal T2 SSFSE

Pancreas: is now identical to liver but

1. Addition of coronal SSFP
2. Thick slab and 3d navigated MRCP on all patients
3. Post-gads only go to 5 minutes, not 15

Spine with contrast: do all post-gads with fat sat except

1. MS / demyelinating disease
2. If tech determines too much artifact to adequately perform T1FS

Please confirm all MRCP performed with in/out of phase

Version 2022b

Lumbar with contrast

- Change axials to be 2 or 3 angled blocks through whole spine to obtain complete coverage, stitch together blocks into 1 sequence

Hip arthrogram: Specify that Axial T1 is axial oblique

3T

- Rectal CA, cervical CA and prostate all should be on 3T
- Exception: Barberton and old COE scanner if s/p hip arthroplasty

Spleen: New protocol (same as routine liver)

MR Urogram: new protocol, includes Lasix (need nursing)

Change MS protocol

New CSF Flow and traumatic brain injury protocols