

# **Akron Radiology Inc. Technique Manual For MRI**

**Including Gadolinium Advisory Statement**

**Version 2020c**

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.<sup>1</sup>

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
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Post Gad:

Axial	T(1) SE
Coronal	T(1) SE
Sagittal	T(1) SE (if tumor present)

BRAIN (KNOWN TUMOR)

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

Axial	T(1) SE
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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)

Routine Brain as above PLUS:

Axial	T(1) SE
Sagittal	FLAIR

Post Gad: (5 minute delay)

Axial	T(1) SE
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## BRAIN (REFRACTORY SEIZURES &lt;70 y.o.)

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

INTERNAL AUDITORY CANALS (Bell's Palsy (7<sup>th</sup> nerve), Trigeminal (5<sup>th</sup> 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

Localize examination for area of concern:

IAC – Internal Auditory Canals

7<sup>th</sup> nerve – Slightly lower than for IAC5<sup>th</sup> 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: ½ DOSE GAD at 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	T(1) SE through entire spine
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Sagittal	T(1) SE
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## 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)
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Post Gad:

Axial	T(1) SE
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Sagittal	T(1) SE
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## 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 - 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 &amp; Post Gad T(1) Axials over entire spine\*

Pre-Gad:

Axial            T(1) SE  
                  T(2) SE  
                  Sagittal        T(1) SE  
                  Sagittal        T(2) FSE  
                  Sagittal        STIR  
                  Sagittal        Diffusion (add if possible if infection suspected)

Post Gad:

Axial            T(1) SE  
                  Sagittal        T(1) SE

## 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)

## 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)  
                   Proton Density FatSat (Bilateral, Open & Closed positions)  
 Coronal        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

## 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  
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

## 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

**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
		T(2) FatSat
Axial		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
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Sagittal		T(1) FatSat
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## 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
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Coronal		T(1) FatSat
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## 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(1) GE  
 STIR  
  
 Post Gad:  
 Axial T(1) GE  
 Coronal T(1) GE  
 Dynamic study with power injection at 0sec(arterial), immediate (venous),  
 90sec, 3min, 5min

## 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) - EOVI

## 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

## 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, & 15min.

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

Perform MR Renal with Gad as above but add Coronal thick slab T2 in place of  
15 min post-gad sequence

## ADRENAL GLAND

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

## PANCREAS

Pre Gad:

Axial	T(1) GE FatSat T(2) FSE FatSat Steady State GE T(2) FSE (Breathhold) Diffusion b0-50 and 800-1000
Coronal	Steady State GE

Post Gad:

Axial	T(1) GE FatSat Dynamic study with power injection at 0sec(arterial), immediate (venous), 90sec, 3min, 5min, & 15min.
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If pancreatic cyst known or detected then add thin slice T(2) MRCP sequence

## 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) 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 (not Fat Sat) – Cor or Sag can be with FatSat

## PELVIS (ENDOMETRIOSIS)

Axial	T(1) SE Fat Sat
	T(2) FatSat
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)

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

Optional – insert 100ml of ultrasound gel into rectum  
 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
	Diffusion b0-50 and 800-1000
Sagittal	T(2) FSE
Coronal	T(2) FSE



## PROSTATE

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

## ABDOMEN/PELVIS (SUSPECTED APPENDICITIS IN PREGNANCY)

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
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## 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

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

2<sup>nd</sup> 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)

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

Neck – change axial precontrast T1 to non-fat sat

Liver – post contrast – remove 15 min delay sequence