

 <small>INCORPORATED PROFESSIONAL SERVICES</small>	<b>Body: MR Protocols</b>		
	Reviewed:	Date: 7/16/2024	J.Finizio
	Revised: Updated body protocols	Date: 3/28/2023	Dr. Call

**Abdomen:**

- A 1: Pre- and post-contrast abdomen MRI
- A 1L: Abdomen MRI without contrast
- A 1P: Pre- and post-contrast abdomen MRI (pancreas protocol)
- A 1R: Pre- and post-contrast abdomen and pelvis MRI (renal protocol)
- A 2: Pre- and post-contrast abdomen MRI (uncooperative patient)
- A 3: MR cholangiopancreatography (MRCP)
- A 4: Abdomen MRI without contrast (adrenal protocol)
- A 5: Pre- and post-contrast abdomen and pelvis MRI (Enterography protocol)
- A 6: Chest, abdomen, *or* pelvis MRI with *OR* without contrast (superficial mass protocol)
- A6a: Pre-and post-contrast Chest (oncology protocol)
- A 7: Abdomen and pelvis MRI with IV contrast

**Pelvis:**

- P 1: Pre- and post-contrast pelvis MRI (gynecologic protocol)
- P 2: Pre- and post-contrast pelvis MRI (non-gynecologic protocol)
- P 2R: Pre- and post-contrast pelvis MRI (rectal cancer protocol)
- P 2P: Multiparametric prostate MRI (prostate protocol)
- P 2K: Non-contrast pelvis MRI (prostate radiation planning protocol)
- P 2JB: Non-contrast pelvis MRI (prostate radiation implant protocol)
- P 3: Pelvis MRI without contrast (appendicitis protocol)
- P 4: Pre- and post-contrast pelvis MRI (urethral and perineal protocol)

P 5: Pelvis MRI with *OR* without contrast (scrotal protocol)

P 6: Pre- and post-contrast pelvis MRI with MR angiography (uterine fibroid embolization protocol)

P7: Pelvis MRI without contrast (placenta accreta protocol)

P8: Pelvis MRI without contrast (pelvic floor protocol)

P9: Pelvis MRI with and without contrast (anal fistula protocol)

## **A 1: Pre- and post-contrast abdomen MRI**

Indications: abdomen pain, liver lesion workup

Sequences: patient supine (preferred) or prone if poor breath-holder.

- Coronal HASTE: all sequences from hepatic dome to iliac crests.
- Axial 2-D FLASH in- and out-of-phase.
- Axial breath-hold T2 FSE: TE >150 msec.
- Axial dynamic VIBE: pre-contrast, arterial, portal venous phases.
- Post-Gd coronal 2-D FLASH or VIBE with fat saturation
- Delayed post-Gd axial VIBE
- Axial DWI and ADC

Comments:

- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2-D FLASH: in-phase, out-of-phase images acquired as a double echo. T1-weighted images will generally not help much in lesion detection, but will address issues of focal hepatic fat and incidental adrenal masses.
- Axial T2 FSE: hemangiomas should approach the signal intensity of simple cysts given the prolonged TE. May perform post-Gd for more efficient use of time.
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=500. ADC.
- DIXON: send water only images
- Eovist contrast: 20-minute delays for final axial VIBE.

## **A 1L: Abdomen MRI without contrast**

Indications: abdomen pain not further specified.

Sequences: patient supine (preferred) or prone if poor breath-holder.

- Coronal HASTE: all sequences from hepatic dome to iliac crests.
- Axial 2-D FLASH in-phase
- Axial 2-D FLASH out-of-phase
- Axial breath-hold T2 FSE: TE >150 msec.
- Axial DWI and ADC.

Comments:

- Limited non-contrast abdomen MRI protocol. Avoid using unless requisition and patient's symptoms are truly vague.
- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2-D FLASH: in-phase, out-of-phase images acquired as a double echo. T1-weighted images will generally not help much in lesion detection, but will address issues of focal hepatic fat and incidental adrenal masses.
- Axial T2 FSE: hemangiomas should approach the signal intensity of simple cysts given the prolonged TE.
- Diffusion: use b=0, b=150, b=500. ADC.
- DIXON: send water only images

## **A 1P: Pre and post contrast abdomen MRI (MRCP/pancreas protocol)**

Indications: pancreatic lesion workup; malignant biliary stricture.

Sequences: patient supine (preferred) or prone if poor breath-holder.

- Coronal HASTE: hepatic dome to iliac crests.
- Axial 2-D FLASH in- and out-of-phase.
- Axial breath-hold T2 FSE with fat saturation or SPAIR
- Oblique coronal thin-slice HASTE through pancreas and CBD.
- Radial 40 mm thick HASTE (MRCP) around the common bile duct
- 3D MRCP with SPACE (available on Avantos only)
- Axial dynamic VIBE: pre-contrast, arterial, portal venous phases.
- Post-Gd coronal 2-D FLASH or VIBE with fat saturation
- Delayed post-Gd axial VIBE
- Axial DWI and ADC.

Comments:

- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2-D FLASH: in-phase, out-of-phase images acquired as a double echo. T1-weighted images will generally not help much in lesion detection, but will address issues of focal hepatic fat and incidental adrenal masses.
- Axial T2 FSE: added fat saturation should increase conspicuity of peripancreatic infiltrative processes.
- DIXON: send water only images
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=500. ADC.

## **A 1R: Pre- and post-contrast abdomen and pelvis MRI (renal protocol)**

Indications: renal mass and hydronephrosis workup

Sequences: patient supine (preferred) or prone if poor breath-holder. All axial sequences span from hepatic dome through bottom of kidneys. Coronal sequences span from hepatic dome to bladder base.

- Coronal HASTE
- Axial 2-D FLASH in- and out-of-phase
- Axial 2-D FLASH in- and out-of-phase with fat saturation
- Axial breath-hold T2 FSE
- MR urogram: coronal 60 mm thick slab HASTE/SPACE.
- Coronal dynamic VIBE: pre-contrast, corticomedullary, nephrographic, and 5-minute delayed/ureteral phases.
- Post-Gd axial VIBE or 2-D FLASH with fat saturation.
- Axial DWI and ADC.
- Add post contrast subtraction images

Comments:

- Pre-exam hydration: 1000 cc of water *OR* 250 cc IV NS (preferred).
- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2D FLASH with fat saturation: T1-weighted sequence should address issue of angiomyolipomas.
- MR urogram details: acquire 10-15 times, each spaced 5-10 seconds apart. Display all images in one series.
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=500. ADC.
- DIXON: send water only images

## **A 2: Pre and post contrast abdomen MRI (uncooperative patient)**

Indications: patients with limited mobility, decreased mental status, and poor breath-holding capability.

Sequences: patient supine.

- Coronal HASTE (preferred) or tru-FISP: liver to iliac crests.
- Axial turbo FLASH: liver dome to iliac crests.
- Axial HASTE (preferred) or tru-FISP: liver dome to iliac crests.
- Dynamic axial VIBE or turbo FLASH with fat saturation: pre-contrast, arterial, and portal venous phases.
- Post-Gd coronal turbo FLASH with fat saturation: liver to iliac crests.

Comments:

- Should ideally be limited to inpatients when other imaging modalities have been exhausted.
- HASTE: can increase slice thickness and inter-slice gaps to decrease patient breath-hold times. Suggested baseline parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.

### **A 3: MR cholangiopancreatography (MRCP)**

Indications: assess for biliary obstructions and strictures. Optional Secretin MRCP to assess pancreatic duct and exocrine pancreatic function.

Sequences: patient supine (preferred); prone if poor breath-holder.

- Coronal HASTE: hepatic dome to iliac crests.
- Axial 2-D FLASH in- and out-of-phase.
- Axial breath-hold T2 FSE with fat saturation or SPAIR
- Oblique coronal thin-slice HASTE through biliary system
- Oblique axial thin-slice HASTE through biliary system
- Radial 40 mm thick HASTE (MRCP) around the common bile duct
- 3D MRCP with SPACE (available on Avantos only)

*Optional: additional secretin MRCP sequences: 60mm thick slabs.*

- Coronal oblique HASTE immediately after injection.
- Coronal oblique HASTE every 30 seconds for up to 5 minutes, then every 60 seconds up to 10 minutes.

#### Comments:

- Coronal HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Thin-slice HASTE parameters: TR 1100/TE 85; BW 195; ST/gap of 4/0, 218 x 256, FOV 30-40, NEX 0.5, coronals interleaved.
- Axial T2 FSE can be limited from top of gallbladder to bottom of pancreas. Fat saturation increases conspicuity of any infiltrative processes around the pancreas.
- Axial 2-D FLASH also does not need to cover entire liver. Provides T1-weighting, and also increases conspicuity of surgical clips.
- Oblique coronal and axial HASTE images oriented with respect to the extra-hepatic bile duct direction.
- DIXON: send water only images

#### *Secretin MRCP details:*

- Patient preparation: fasting for 4 hours prior to exam.



- Negative oral contrast agent to reduce signal from overlying stomach, taken a few minutes before exam: 300 mL GastroMark, pineapple or blueberry juice.

Secretin dose: 16  $\mu\text{g}$  in adults, 0.2  $\mu\text{g}/\text{kg}$  in pediatric patients. Administer slowly over 1 minute, NOT as bolus, to minimize patient discomfort.

#### **A 4: Abdomen MRI without contrast (adrenal protocol)**

Indications: adrenal adenomas versus malignancy.

Sequences: patient supine.

- Coronal HASTE: hepatic dome to iliac crests.
- Axial 2-D FLASH in-phase
- Axial 2-D FLASH out-of-phase
- Axial 2-D FLASH subtraction images.

Comments:

- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2-D FLASH: in-phase, out-of-phase images acquired as a double echo to minimize misregistration for the subtraction images. Acquire from hepatic dome to bottom of kidneys.
- If other abdominal findings (ie., liver lesions) also need to be worked up concomitantly, perform abdomen survey instead, as adrenal workup sequences are incorporated into that protocol.
- DIXON: send water only images
- Subtraction images: the order of sequence subtraction is critical. Correct way: In-phase images MINUS out-of-phase images. Hint: sequence with the higher TE, MINUS sequence with the lower TE.

## **A 5: Pre- and post-contrast abdomen and pelvis MRI (enterography protocol)**

Indications: Crohn's disease, bowel wall lesion characterization.

Sequences: patient prone (preferred).

- Coronal T2 HASTE: top of kidneys to symphysis
- Coronal T2 HASTE with fat saturation
- Coronal T2 FISP Cines
- Axial DWI and ADC.
- Axial 2-D FLASH in- and out-of-phase.
- Axial T2 HASTE
- Coronal T1 with fat saturation:
- Axial T1 with fat saturation:
- Scan 60-80 sec after injection
- Post-Gd Coronal T1 VIBE with fat saturation:
- Post-Gd Axial T1 VIBE with fat saturation:
- Post-Gd Coronal T1 VIBE with fat saturation: 5 min Delay

Comments:

- Large FOV focusing on Abdomen - (Please do not split into upper and lower abdomen, which divides the key diagnostic area: terminal ileum)
- Prone positioning will spread out bowel loops and decrease number of coronal slices needed for adequate coverage.
- Oral contrast: two bottles of Volumen (450 mL x 2) oral contrast, 75 minutes prior to scan.
- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- 5-10 minutes before, administer 0.25 mg Levsin sublingually. Contraindications: glaucoma, bowel distention, myasthenia gravis, urinary obstruction, unstable heart disease.
- Axial HASTE: typically, 4 sets of images will be needed for adequate coverage.
- DIXON: send water only images

- Post-Gd images done after a 60-80 second delay. Acquire images out-of-phase to enhance fat saturation.

**A 6: Chest, abdomen, *or* pelvis MRI with *or* without contrast (superficial mass protocol)**

Indications: abdominal or chest wall lesion.

Sequences: place fiducial over area of concern; use smallest possible coil.

- Axial 2-D FLASH in-phase.
- Axial 2-D FLASH out-of-phase.
- Axial breath-hold T2 FSE
- Axial STIR FSE
- Post-Gd axial 2-D FLASH with fat saturation.

Comments:

- Acquire pre-contrast 2-D FLASH separately to enhance signal-to-noise ratio.
- Use EKG gating or flip phase/frequency if lesion is anterior to the heart.
- Gadolinium can be skipped if lesion has appearances of lipoma.
- Suggested post-Gd delays: chest 25 sec, abdomen 30 sec, pelvis 35 sec.  
Better to wait too long than not long enough.

## **A 6a : Pre- and post-contrast Chest MR (oncology protocol)**

Indications: Intrathoracic(non-MSK) lesion or malignancy evaluation/follow-up

Sequences:

Pre-Contrast:

- Axial in- and out-of-phase.
- Coronal in- and out-of-phase.
- Axial HASTE (Full Chest)
- Coronal HASTE (Full Chest)
- Axial Diffusion (Full Chest)
- Axial T2 FS (Use small FOV if focusing on particular lesion)
- Axial VIBE FS thins pre-contrast (Full Chest)
- Post-Gd coronal 2-D FLASH or VIBE with fat saturation
- *Opt: Axial DWI and ADC.*

Post-Contrast:

- Axial VIBE FS thins (Full Chest)
- Axial VIBE FS thins small FOV (optional if focusing on particular lesion.)
- Coronal VIBE thins (Full Chest)

## **A 7: Abdomen and pelvis MRI with IV contrast**

Indications: Screening alternative to CT, cancer follow up

Sequences: hepatic dome to iliac crests and iliac crests to symphysis

- Coronal HASTE.
- Axial 2-D FLASH in- and out-of-phase.
- Axial DWI and ADC
- Axial breath-hold T2
- Axial breath-hold T2 fat saturation blade
- Coronal T1
- Coronal STIR
- Axial T1
- Axial STIR
- Axial dynamic VIBE: pre-contrast for abdomen and pelvis
- Axial dynamic VIBE: arterial, portal venous phases for abdomen
- Axial dynamic VIBE: late portal venous phase for pelvis
- Delayed post-contrast axial VIBE
- Delayed post-contrast coronal VIBE

Comments:

- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Axial 2-D FLASH: in-phase, out-of-phase images acquired as a double echo. T1-weighted images will generally not help much in lesion detection, but will address issues of focal hepatic fat and incidental adrenal masses.
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=500. ADC.
- DIXON: send water only images

## **P 1: Pre- and post-contrast pelvis MRI (gynecologic protocol)**

Indications: female pelvic pain, uterine and ovarian lesions.

Sequences: patient supine; scan from iliac wings or top of uterus to symphysis.

- Coronal HASTE
- Sagittal breath-hold T2 FSE (pelvic sidewall to sidewall).
- Uterine long-axis T2 FSE (non-breath-hold)
- Uterine short-axis T2 FSE (non-breath-hold)
- Axial T1 FSE: iliac crests to symphysis.
- Axial T1 FSE with fat saturation: iliac crests to symphysis.
- Axial post-Gd VIBE or 2-D FLASH with fat saturation
- Coronal post-Gd VIBE or 2-D FLASH with fat saturation
- Sagittal post-Gd VIBE or 2-D FLASH with fat saturation for uterine lesions.
- Axial DWI and ADC.

Comments:

- Patient Prep: Consider Fleet Enema prior to scan (*Right before patient leaves home to come to exam*)
- For known cervical and uterine mass workups, have patient inject 60 cc of prepared Surgilube in a cath-tip syringe attached to a truncated Yankauer suction device. Brown et al. AJR 2005; 185: 1221-1227.
- Coronal HASTE: survey sequence with heavy T2 weighting. Suggested parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Sagittal T2 FSE: look for pelvic lymphadenopathy. Also used to set up for uterine T2 FSE images.
- Can skip uterine T2 FSE sequences if status post hysterectomy or if exam is done for ovarian pathology.
- Axial 2-D FLASH: useful for assessing ovarian desmoids or other fat-containing lesions.
- Axial T1 FSE with fat saturation: look for endometriosis deposits. Place superior and inferior sat bands to avoid venous inflow signal.
- VIBE planes: sagittal if exam done for uterine pathology, axial for all other indications.



- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.

## **P 2: Pre- and post-contrast pelvis MRI (non-gynecologic protocol)**

Indications: pelvic pain, bladder cancer.

Sequences: patient supine. Scan from iliac crests to symphysis.

- Coronal HASTE
- Sagittal non-breath-hold T2 FSE (pelvic sidewall to sidewall).
- Axial T1 FSE: iliac crests to symphysis.
- Axial non-breath-hold T2 FSE (small FOV to pelvic sidewalls)
- Coronal non-breath-hold T2 FSE (small FOV to pelvic sidewalls)
- Axial dynamic VIBE: pre-, arterial, venous phases
- Coronal and axial post-Gd VIBE or 2-D FLASH with fat saturation
- Axial DWI and ADC.

Comments:

- Patient Prep: Consider Fleet Enema prior to scan (*Right before patient leaves home to come to exam*)
- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- 5-10 minutes before, administer 0.25 mg Levsin sublingually. Contraindications: glaucoma, bowel distention, myasthenia gravis, urinary obstruction, unstable heart disease.
- Sagittal T2 FSE: look for pelvic lymphadenopathy.
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=800. ADC.

## **P 2R: Pre- and post-contrast pelvis MRI (rectal cancer protocol)**

Indications: staging of known rectal cancer.

Sequences: patient supine, with saturation band across abdominal wall. Scan from iliac crests to symphysis.

- Sagittal HASTE.
- Axial T2 FSE
- Oblique axial and coronal T2 FSE (FOV 18): orient to mass lesion.
- Axial T1 FSE.
- Axial pre-Gd VIBE.
- Sagittal, coronal and axial post-Gd VIBE or 2-D FLASH with fat saturation (FOV 18). No dynamic imaging needed.
- Axial DWI and ADC.

Comments:

- Patient Prep: Fleet Enema prior to scan (*Right before patient leaves home to come to exam*)
- Patients should empty bowel and bladder right before scan. For mid to high rectal tumors, consider 60-100 mL warm US gel as rectal contrast.
- FOV around 30 cm, except when specified as small FOV as above.
- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- 5-10 minutes before, administer 0.25 mg Levsin sublingually. Contraindications: glaucoma, bowel distention, myasthenia gravis, urinary obstruction, unstable heart disease.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.
- Diffusion: use b=0, b=150, b=500-800. ADC.

## **P 2P: Multiparametric prostate MRI (prostate protocol)**

Indications: Screening, known prostate cancer, assess for extra-capsular invasion.

Sequences: patient supine. Scan from iliac crests to symphysis only.

- Localizer
- Coronal T2 HASTE
- Axial T1 FSE with fat saturation
- Axial non-breath-hold T2 FSE (small FOV through prostate)
- Coronal non-breath-hold T2 FSE (small FOV)
- Sagittal non-breath-hold T2 FSE (small FOV)
- Axial DWI and ADC.
- Dynamic post-Gd axial VIBE through prostate (6 time points).
- Axial post-Gd VIBE or 2-D FLASH with fat saturation
- Coronal post-Gd VIBE or 2-D FLASH with fat saturation

Comments:

- Patient Prep: Fleet Enema prior to scan (*Right before patient leaves home to come to exam*)
- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- T2 FSE specifications (if technically possible): ST 3mm no gap, FOV 12-20 cm, pixel size 0.7 mm or less (phase) and 0.4 mm or less (frequency).
- 3D SPACE option *in addition to* T2 FSE sequences: TR/TE 1200/141, flip angle 150 degrees, ETL 67, 2 echo trains per slice, partition thickness 1.5 mm, FOV 192 x 192 mm, 192 x 123 matrix, receiver bw 744 Hz/pixel, iPat 2, NEX 2. Reconstruct at 3 mm thickness in 3 planes.
- DWI specifications (if technically possible): TE 90 ms or less, TR 3000 or more. ST 3 mm no gap. FOV 16-22 cm, pixel size 2.5 mm or less (phase and frequency). B values: 50, 800, 1400. ADC.
- **Match small FOV** of axial prostate and ADC/ DWI.
- Suggested VIBE timing formula: Delay =  $\frac{1}{2}$  injection time + arrival time –  $\frac{1}{2}$  acquisition time + fudge factor (4 sec). Arrival time = time to peak signal in abdominal aorta.
- Dynamic contrast enhancement (DCE): Dose: 0.1 mmol/kg standard contrast, injection rate 2-3 mL/sec. 3D VIBE preferred, fat saturation. TR

<100 ms, TE <5 ms. ST 3 mm no gap, FOV to cover prostate gland and seminal vesicles, pixel size 2 x 2 mm or less. Temporal resolution: <7 sec preferred. **Post contrast dynamic images: 6** time points should be sufficient. Do not need subtractions.

- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.

**P2K: Non-contrast pelvis MRI (prostate radiation planning protocol)**

Indications: radiation therapy planning for prostate cancer for Dr. Kantorowitz's patients

Sequences:

- Axial GRE with the following parameters: 2 mm slice thickness with 0 mm gap, TR/TE = 650/15 ms, flip angle 25 degrees, bandwidth of 15.6 kHz, FOV = 20 cm, spatial resolution of 256 x 192, NEX = 2.

Comments:

- Scan to include top of seminal vesicles all the way down to include the base of the penis.

**P2JB: Non-contrast pelvis MRI (prostate radiation implant protocol, from Jim Borrow of First Hill Imaging)**

Indications: radiation implant planning for prostate cancer, courtesy of Dr. Jim Borrow from First Hill Imaging.

<b>Sequence</b>	<b>TR/TE</b>	<b>Phase encode</b>	<b>ST/g ap</b>	<b>Matrix</b>	<b>FOV (cm)</b>	<b>Notes</b>
<b>Axial T2 RESTORE</b>	5250/122	L to R	2.5/0	384/380	24	100% oversample 50 slices 2 concatenations, 2 averages
<b>Axial T1</b>	600/12	L to R	2.5/0	384/380	24	100% oversample 50 slices 5 concatenations, 1 average
<b>Axial STIR</b>	5000/76 TI of 150	L to R	2.5/0	256/256	24	100% oversample 50 slices 3 concatenations, 1 average
<b>Coronal T2</b>	5000/128	L to R	2.5/0	384/380	24	100% oversample 40 slices 2 concatenations, 1 average
<b>Sagittal T2</b>	5420/128	A to P	2.5/0	384/380	24	100% oversample 40 slices 2 concatenations,

						1 average
<b>Axial DWI/ADC</b>	10900/85 b 0, 50, 750	L to R	5.0/0	192/100	32- 45	18% oversample 36 slices 2 averages

Comments:

- Use phased array coil.
- Adjust FOV to patient size.
- Subject to revisions, including using glucagon and Gadolinium.



### **P 3: Pelvis MRI without contrast (appendicitis protocol)**

Indications: assess for appendicitis in a pregnant female *after* an inconclusive ultrasound.

Sequences: patient supine.

- Coronal HASTE
- Axial HASTE
- Sagittal HASTE
- Axial HASTE with fat saturation
- Axial 2D TOF
- Axial 2D FLASH in- and out-of-phase.
- Axial DWI and ADC.

Comments:

- Scan coverage: kidneys through symphysis. FOV 30-40 cm.
- Suggested HASTE parameters: ST/gap 4/1, 256 x 192 matrix, TR 800-1100/TE 60-80, NEX 1.
- Suggested axial 2D time of flight parameters: ST/gap of 3/1, 256 x 128 matrix, TR 300-360, TE 4.5-10, non-breath hold.
- Suggested DWI parameters: ST/gap of 5/0, 64 x 64 matrix.
- Suggested axial 2D FLASH parameters: ST gap of 5/1, 256 x 160 matrix.
- Radiologist to check images before patient leaves.

### **GUIDELINES ON PERFORMING APPENDICITIS MRI:**

- Gadolinium is relatively contra-indicated in **ALL** pregnant patients.
- Even though MRI has to date demonstrated no adverse effects to the fetus, it is relatively contra-indicated in the first trimester due to the amount of organogenesis in early pregnancy.
- Because the long-term effects of MRI on the fetus are still unknown, MRI is a second-line test to evaluate right abdominal pain after an inconclusive ultrasound, when the only available other imaging options involve ionizing radiation.

- Radiologist's option: oral mixture of 300cc of GastroMark and 300cc ReadiCat ingested 90 minutes before imaging may improve visualization of the cecum and appendix by providing negative contrast.

#### **P 4: Pre- and post-contrast pelvis MRI (urethral and perineal protocol)**

Indications: assess and characterize urethral diverticula/masses.

Sequences: patient supine.

- Coronal HASTE: iliac crests to symphysis
- Axial non-breath-hold T2 FSE: small FOV from bladder to perineum.
- Sagittal non-breath-hold T2 FSE: small FOV centered on urethra.
- Coronal non-breath-hold T2 FSE: small FOV centered on urethra.
- Axial DWI and ADC.
- Axial T1 FSE: iliac crests to symphysis.
- Axial 2-D FLASH in-phase with fat saturation: small FOV
- Post-Gd axial VIBE or 2-D FLASH with fat saturation: small FOV
- Post-Gd sagittal VIBE or 2-D FLASH with fat saturation: small FOV

Comments:

- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- All but initial sequence performed with coned-down field of view centered on the urethra and bladder.

## **P 5: Pelvis MRI with *or* without contrast (scrotal protocol)**

Indications: testicular masses or infection.

Sequences: patient supine.

- Coronal HASTE (iliac crests through perineum)
- Axial T1 FSE (small FOV)
- Axial T2 FSE (small FOV)
- Coronal T1 FSE (small FOV)
- Coronal T2 FSE (small FOV)
- Axial DWI and ADC.
- *Optional:* axial and/or coronal T1 FSE with fat saturation
- *Optional:* post-Gd axial and/or coronal T1 FSE with fat saturation

Comments:

- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- All but initial sequence performed with coned-down field of view (FOV) centered on the scrotum.
- Give Gadolinium only for infections or abscess, NOT for tumor workup (will not change the diagnosis).

**P 6: Pre- and post-contrast pelvis MRI with MR angiography (uterine fibroid embolization protocol)**

Indications: characterize fibroids, planning study for embolization.

Sequences: patient supine. Scan from top of uterus to symphysis

- Coronal HASTE
- Sagittal breath-hold T2 FSE: center on uterus
- Uterine long axis breath-hold T2 FSE
- Uterine short axis breath-hold T2 FSE
- Axial DWI and ADC.
- Axial T1 FSE: iliac wings to symphysis.
- Coronal MRA: pre-Gd, arterial phase, delayed venous phase.
- Post-Gd sagittal VIBE or 2-D FLASH with fat saturation.

Comments:

- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Perform post-Gd 2-D FLASH out-of-phase to enhance fat saturation.

## **P 7: Pelvis MRI without contrast (placenta accreta protocol)**

Indications: assess for placenta accreta or percreta in the setting of prior C-sections and/or placenta previa.

Sequences: patient supine. Scan from top of uterus to symphysis

- Coronal HASTE
- Axial HASTE
- Sagittal HASTE
- Sagittal T2 FSE (non-breath-hold), FOV centered on placenta.
- Axial T2 FSE with fat saturation (non-breath-hold), FOV centered on placenta
- Axial T1 FSE.
- Axial DWI and ADC.

Comments:

- Suggested coronal HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- Interpreting radiologist to check exam and add any additional sequences before patient leaves the scanner.

## **P 8: Pelvis MRI without contrast (pelvic floor protocol)**

Indications: assess pelvic floor dysfunction, pelvic organ prolapse, urinary and defecatory abnormalities.

Sequences: patient supine, with wedge under slightly spread knees.

- Sagittal HASTE at rest.
- Sagittal truFISP during Valsalva.
- Sagittal HASTE during Valsalva.
- Coronal HASTE during Valsalva.
- Axial T2 FSE at rest.
- Coronal T2 FSE at rest.

Comments:

- Suggested HASTE parameters: ST/gap of 6/0, 256x256, FOV 35. Scan from femoral head to femoral head.
- TruFISP parameters: continuous 60 sec acquisition along mid sagittal 6 mm slice.
- T2 FSE parameters: 4 mm ST, FOV 30, 300x384 matrix.

## **P 9: Pre- and post-contrast pelvis MRI (anal fistula protocol)**

Indications: assess and characterize anal fistulas and abscesses.

Sequences: patient supine.

- Coronal HASTE: iliac crests to symphysis
- Sagittal non-breath-hold T2 FSE: 30 x 30 FOV, 2.5 mm ST w/ 0 gap. 320 x 256 matrix.
- Oblique axial non-breath-hold T2 FSE with fat saturation: 26 x 26 FOV, 4.0 mm ST w/ 1 mm gap. 384 x 224 matrix.
- Oblique coronal non-breath-hold T2 FSE with fat saturation: 24 x 24 FOV, 4.0 mm ST w/ 1 mm gap. 512 x 224 matrix. Oblique axial T1 FSE: 26 x 26 FOV, 4.0 mm ST w/ 1 mm gap. 384 x 224 matrix.
- Axial DWI and ADC.
- Post-Gd oblique axial VIBE or T1 FSE with fat saturation: 26 x 26 FOV, 4.0 mm ST w/ 1 mm gap. 384 x 224 matrix.

Post-Gd oblique coronal VIBE or T1 FSE with fat saturation: 24 x 24 FOV, 4.0 mm ST w/ 1 mm gap. 512 x 224 matrix. Comments:

- Suggested HASTE parameters: TR 1060/TE 116; BW 195; ST/gap of 6/0, 256x256, FOV 30-40, phase R/L, NEX 1, R&L sat bands, interleaved.
- All oblique axial and coronal sequences should be oriented perpendicular and parallel to the anal canal, respectively, based off the sagittal sequence.
- 3D SPACE may be substituted for the T2 FSE sequences if available on scanner.