Austin Radiological Association

MRI Pediatric Protocols

Pediatric 1.5T

Questions?

Last Update: 6/7/2024 10:21 AM

Contents

Guidelines

GENERAL
• Patients between the ages of 0 – 17 years of age are considered pediatric

TECHNIQUE
• T1 is conventional SE T1 unless specifically stated otherwise; T2's weighted are FSE. • Frequency direction should be perpendicular to plane of growth plate most of interest – and please switch phase and frequency if vascular artifacts obscure structures of interest. • Use a TI of 150 for FSE IR. • Need for extra set for whole bone in pedi is because of skip lesions in tumor and marrow diseases. • Calculating pixel size: FOV/matrix x FOV/matrix ACR: must include entire boney pelvis

BODY	
Technique	• Careful of tight FOVs with the use of iPAT, the combination of the two can lead to artifacts. • Arterial phase is most crucial with liver imaging. Care bolus series should be prescribed in an axial plane and positioned just inferior to right side diaphragm & the immediate post initiated when contrast is seen in descending aorta. • Delayed post series to be performed 5 minutes post injection at minimum.
Protocol	• Glucagon is needed for enterography studies • Volume measurement is performed by CT 3D Lab. Reserve study in pending 3D folder in PACS, e-mail *3DPostprocessing with details
Contrast	• Always perform T1 FS Axial Pre, even if not contrasting • Abdominal Contrast – full dose by weight, 3ml/sec, following by 20ml normal saline flush • X-ray / CT abdomen and pelvis imaging must be performed prior to MR contrast exams. • DatScans must be performed prior to MR contrast exams.
Sedation	• MRCP – can sedate, but do not give patient oral contrast agent with radiologist approval. • Enterography – do not sedate • Defecography – do not sedate

MSK	
General	• Perform adult protocol unless specifically requested for Pedi Rad to read. • MSK Guidelines, portal page reference • T1 & T2 weighted imaging is needed to accurately differentiate mass and infection • PD's are generally useful for tendons, ligaments, & joint spaces • Prior x-ray from mass / tumor exams required, if applicable

Technique	• ALL MSK mass / infection exams should be performed using is T1 & T2 FS all 3 planes with appropriate T1 FS pre & post.
	• Generally short axis to the mass is the best option for pre/post imaging.
	• T1 (generally coronal) for ALL bone metastasis, infection or fracture cases.
	• Metal Protocols
	  • Total joint replacements use T1 & IR series (TSE/FSE sequence types)
	  • Hardware such as pins, screws, etc. use standard protocols with metal reduction techniques
	  • Metal reduction techniques
	  • Bandwidth 400 Hz or more with signal compensation, fast RF mode
	  • E-line (3T & Aera) WARP on, VAT 100%

Protocol	• Pelvis vs Hip
	• Hip – evaluation of cartilage & labrum
	• Pelvis – evaluation of fractures, soft tissue & cancer
	• AVN, Osteonecrosis or history of "steroid use with hip pain"
	• Cancer (mass, tumor), metastasis, myeloma
	• Long Bones
	  • Focal symptoms, mass or bone lesion
	  • Image area of interest only
	  • Do not need to include joint to joint, single joint imaging will suffice to target location of pathology
	  • Center axials on area of interest, no need to include joint. DO NOT split pathology in upper / lower axial series
	  • General pain, myositis, cellulitis or non-focal history
	  • Image anatomy as indicated

	• Inflammatory Arthritis (rheumatoid arthritis, psoriatic arthritis, juvenile rheumatoid arthritis, reactive arthritis, gout, C PPD [calcium pyrophosphate deposition disease], or septic arthritis)
	  • The entire hand and entire foot must be scanned for arthritis cases without any other indications such as a tear or mass
	  • Contrast is needed to differentiate joint fluid from synovitis
	  • If a hand and wrist exam are ordered with a diagnosis of arthritis without any other indications, the wrist and hand need to be scanned together in the same FOV
	• History of pigmented villonodular synovitis (PVNS)
	• Add T1 Coronal for all joint studies

Contrast	• T1 FS Pre & T1 FS Post of same plane required for all contrast exams • Do not perform T1 FS Pre if not contrasting
Sedation	•

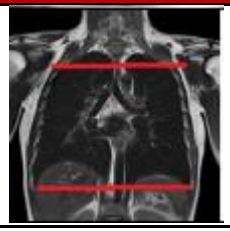
1.5T and 3T Preferred Exams

1.5T	3T
•	• Fingers • Toes Also available at GTN for contraindicated patients

Aorta Coarctation

(Updated 5/15/09)

- Perform at CIC only

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
FSE Black Blood Ax BH	according to patient size		ECG gated if PT unable to hold breath	
FSE Black Blood Obl Cor BH			ECG gated if PT unable to hold breath	
FSE Black Blood Obl Sag BH			ECG gated if PT unable to hold breath	
Cine Obl Sag Aortic Arch			16 – 25 frames per cardiac cycle	
Cine Obl Cor Aortic Isthmus			16 – 25 frames per cardiac cycle	
VENC Cine Obl Sag				
VENC Cine Obl Cor				
VENC Cine Ax (optional)			• Include if measurement on VENC Cine Sag / Cor is insufficient • Distal to coarctation	
Angio3D Obl Sag Pre BH *Care Bolus* *3ml/sec, 20ml flush* Angio3D Obl Sag Pre BH Angio3D Obl Sag Pre BH			Thoracic aorta	

Volumetrics – add LVOT & RVOT cine sequences with short axic cine. Requires post processing for volume & flow analysis.

Dermatomyositis

- Large FOV for edema mapping, low resolution
- Include entire area of interest in one FOV, do not perform as upper/lower
- Do not perform on Espree if area of interest will require separate FOVs

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
TI Cor HASTE IR Cor	according to patient size		Include bilateral pelvis through distal thighs	
T2 FS Ax	according to patient size		Include bilateral pelvis through distal thighs	

For taller patients rad approval required to cover proximal pblvis through distal quad attachment.

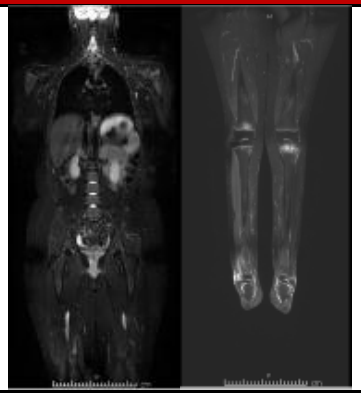
Vascular Mass / Birthmark

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Ax T1 FL2D Ax T2 FS Ax (STIR, if poor FS)				
T1 Cor (optional) T2 FS Cor (STIR, if poor FS)			T1 Cor, if pathology is medial or lateral	
T1 Sag T2 FS Sag (SITR, if poor FS)			T1 Sag, if pathology is anterior or posterior	
Diffusion Ax, optional (50, 400, 800 B-values)				
T1 FS Ax Pre				
Angio3D Cor Pre Administer contrast Angio3D Cor Post Angio3D Cor Delay Post Angio3D Cor Delay Post			Perform for initial study or for AVM	
T1 FS Ax Post				
T2 FS Cor Post				
T1 FS Sag Post				
Diffusion & MRA are determined on a case by case basis, contact pedi rad to confirm necessity. (Dr. Banks or Dr. Baker)				

Whole Body

(CRMO – chronic recurrent multifocal osteomyelitis, oncology screening such as p53 mutation)

CRMO – without contrast
Oncology Screening – without & with contrast

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
STIR Cor T1 Cor	450	5 x 0	Orbits through toes, to include humeri, forearms, & hands	
T2 FS Ax	450 - 500	5 x 0.8	Orbits through toes, to include humeri, forearms, & hands	
STIR Sag	400	3 x 1	• Add for CRMO • Whole spine	
T1 FS Cor Post			Add for oncology screening	Copies to STIR Cor

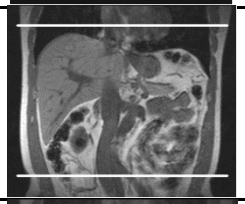
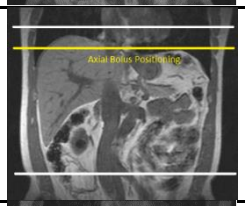
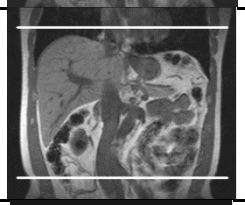
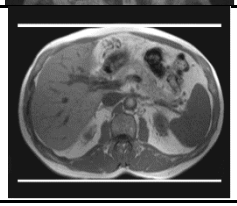
ARA – without extended table move option
- HFS – TIM planning of upper (orbit through mid-femur)
- FFS – TIM planning of lower (mid-femur through to toes)

Body

Abdomen

(Updated 6/7/24)

- Include total renal volume for polycystic disease.

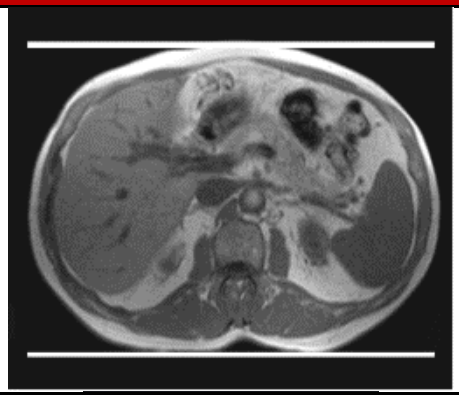
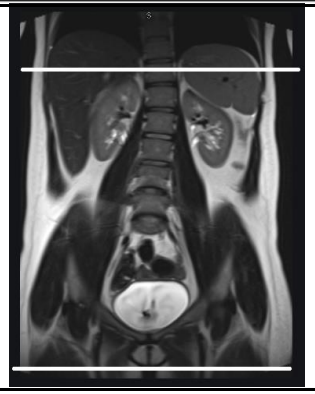
SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Cor T2 FS Cor (HASTE / SSFE, if needed)	~340	8 x 2		
T1 Ax T2 FS Ax (HASTE / SSFE, if needed)	~320	7 x 2 ~24 slices		
Ax Care Bolus			Begin immediate post when contrast is visualized in the aorta, take into consideration of breath hold instructions.	
T1 FS VIBE Ax Immediate Post	~320	3 – 4		
T1 FS Cor Post	~340	8 x 2		

- Send care bolus and subtractions to PACS

Abdomen – Pelvis: Undescended Testis

- Do not perform RCP MR1, SM, SW MR1, WLK or WMC
- Scheduled as MRABS, MRPES

Include kidneys through scrotum.

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Cor T2 Cor T2 FS Cor (HASTE / SSFE)	~380	3 – 5 x 1	Slice thickness dependent upon PT size	
T1 Ax T2 Ax STIR Ax	~320	3 – 5 x 1		
Diffusion Ax (B50, 800)	~320	5 x 1		Copies center to T1 Ax

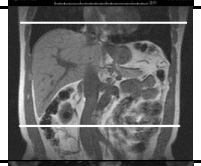
•

Kidneys

(new finding and follow up renal lesion, tuberous sclerosis)

(Updated 6/7/24)

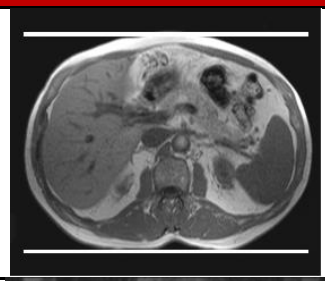
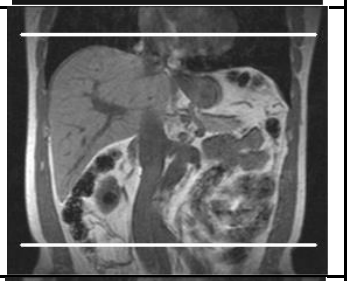
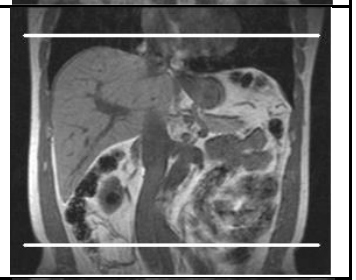
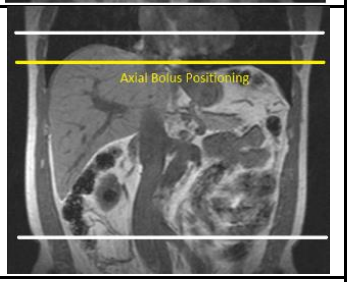
- Perform routine abdomen protocol if exam is follow up post nephrectomy. This is to better visualize the renal bed and surrounding organs
- Include total renal volume for polycystic disease.

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T2 HASTE Cor BH	~360	4 x 0 ~30 slices	Include kidneys and mass	
T1 In/Out Ax BH	~360	7 x 2 ~24 slices	Include entire liver and kidneys	
T1 Ax BH T2 FS Ax BH T2 HASTE Ax BH	~360	4 x 0 ~36 slices	Include kidneys and mass	
T1 FS VIBE Ax Pre BH *Ax Care Bolus* T1 FS VIBE Ax Immediate Post BH	~360	3 x 0		Copies center T1 Ax
T1 FS VIBE Cor post BH	~360	3 x 0	Scanned after immediate post	
T1 FS VIBE Ax Delayed Post BH	~360	3 x 0	Delayed series must be at least 5 min post injection.	
Pyelo (post contrast)				
T2 FS Cor Post Fast STIR Cor (TE 20)				Copies to Fast STIR Cor
Calyceal Diverticulum (delayed post contrast)				
T1 FS VIBE Axial Post Delay 15-min	~360	3 x 0		Copies to T1 Ax

- T1 FS VIBE Ax Pre must be performed on all abdomens without contrast
- Austin Kidney Associates: if requested for total kidney volume reserve exam for 3D lab to process then send an email to 3D_Postprocessing@ausrad.com
- Send care bolus and subtractions to PACS

Liver

(hemangioma, lesion)

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Cor T2 FS Cor	~340	8 x 2		
T1 In/Out Ax T2 FS Ax BH Heavy T2 Ax	~320	7 x 2 ~24 slices		
T1 FS VIBE Ax Pre	~320	3 – 4	Slice thickness, as thin as possible within single breath hold.	
Ax Care Bolus			Begin immediate post when contrast is visualized in the aorta, take into consideration of breath hold instructions.	
T1 FS VIBE Ax Immediate Post T1 FS VIBE Ax 2 min Post T1 FS VIBE Ax 5 min Post T1 FS VIBE Ax 10 min Post	~320	3 – 4	Delayed series must be at least 5 min post injection.	

- T1 FS VIBE Ax Pre must be performed on all abdomens without contrast
- Send care bolus and subtractions to PACS

Pelvis: female

(primary amenorrhea, other gynecologic symptoms)

- With empty bladder. If bladder is area of interest, then image with full bladder

Adult Protocol

- Mullerian duct – for all gynecological symptoms
- Routine – ovarian or pelvis tumor

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES

See Adult Protocols

Discuss with pedi rad as needed

Tumor

(Updated 5/11/21)

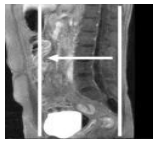
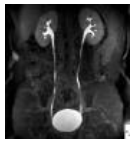
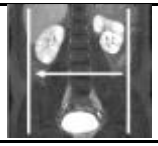
Taylor FOV & slice thickness to area of interest.				
SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Cor HASTE IR Cor				
HASTE IR Sag				
T1 FL2D Out Ax T2 FS Ax T1 FS Ax Pre *Administer contrast*				
T1 FS Ax Post				
T1 FS Cor Post				

Urogram

- Do not scan on an Espree due to the limited H-F FOV

Prep:
- 60-minute arrival
- Ringer lactate IV, total dose 10ml/Kg at approximately 1 liter/hour, 30 – 40 minutes prior to imaging

Positioning
- Supine
- Inject Lasix 1mg/Kg, max dose 20mg over 2 minutes (approximately 15 minutes prior to contrast)
- Confirm with radiologist if urinary catheter is required

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T2 Trufi Ax T2 FS Trufi Ax T2 HASTE Ax	~340	8 x 0 ~42 slices	Scan from above kidneys through bladder / perineum	
T2 Trufi Cor T2 HASTE Cor T2 Space Cor trigger (RT / LT Lateral MIPs)	~380	5 x 1.5	Kidneys, ureters, and bladder Angle along aorta / ureters for true coronal	
T1 VIBE Cor		2.5 x 0		
T1 FS VIBE Cor Dynamic (25 measurements, inject after 1st measurement) *Administer contrast bolus 0.5ml/sec*	~340	4 x 0		
T1 FS VIBE Ax Post				
T1 FS VIBE Cor Dynamic FB (6 measurements)				
T1 FS VIBE Ax Delay Post				
T1 FS VIBE Cor Delay Post				
T1 FS VIBE Ax Delay Post				
T1 FS VIBE Sag Delay Post				

- If you have any question whether enough contrast is seen in the Kidneys, Ureters, and Bladder, Check with a Radiologist prior to getting the patient off the table.

Joint: Routine / Arthritis

Perform adult protocol

Adult Protocol

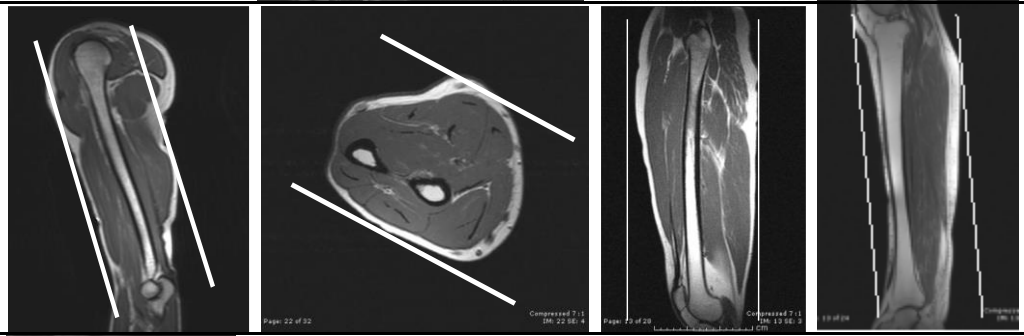
- Cartilage – congenital & developmental malformation, Blount's disease, post-traumatic or post-infection of bony bridges of growth plate
- Ankle – tarsal coalition
- Hip Unilateral – Legg-Perthes, dysplasia
- Joint – acute or chronic pain
- Shoulder – dysplasia

SEQUENCES	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES

See adult protocol

Long Bone
(routine, tumor, infection)

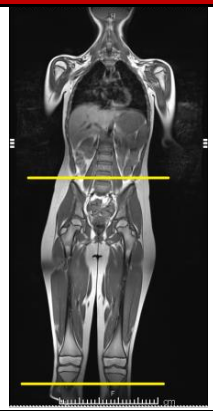
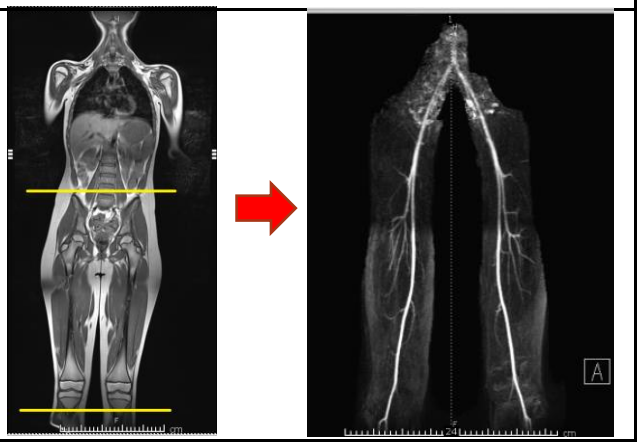
- Taylor FOV to body part
- Must include entire lesion including edema.
- Review with an MSK radiologist to see if IV contrast is needed (some lesions don't, e.g., osteochondroma).

SEQUENCE	FOV (mm)	SLICE (mm)	IMAGES
T1 Ax STIR Ax	~140 According to area of interest	4-5 x 1	
T1 Cor STIR Cor	~240 - 400 According to area of interest	4-5 x 1	
T1 Sag STIR Sag	~240 - 400 According to area of interest	4-5 x 1	

Morphea / Scleroderma

Updated 6/28/22

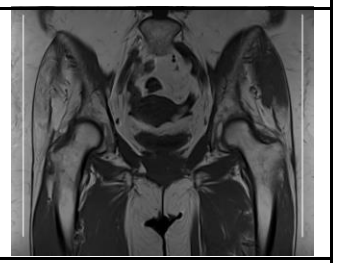
MSK Pelvis & Bilateral Femur With & Without

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Ax T2 FS DIXON Ax (2-3 sections pending PT size)	400	3.5 x 22%	• Include bifurcation through below the knee joint • TIM Planning Stack + or perform individual sequences & save into 1 series in Viewer; do not auto-compose axials	
Diffusion Ax (0, 500, 1000)	400	5 x 13%	•	Copies coverage from T1 Ax
PD SPACE Cor T1 VIBE DIXON Cor Pre	400	1mm	• Include bifurcation through below the knee joint, upper/lower	
TWIST Cor	400 - 450	1.7mm (1 Slab, 120 slices)	• Include bifurcation through below the knee joint, upper/lower. Compose upper/lower	
T1 VIBE DIXON Cor Post (upper/lower)		1mm		

• Send FastView localizer to all 3 exams in PACS.

Pelvis: imperforate anus

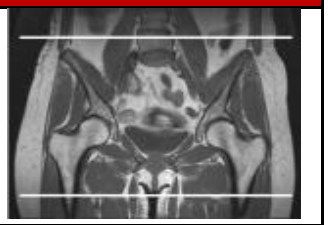
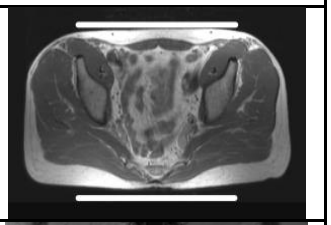
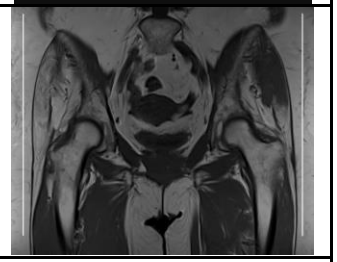
- With empty bladder

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Cor T2 Cor HASTE IR Cor*	~300 mm (increase FOV if need)	5 x 1 (3 x 0)	Must include entire boney pelvis	
T1 Ax T2 FS Ax	~300 (increase FOV if needed)	5 x 1 (3 x 0)		
T2 Sag	~300 (increase FOV if needed)	5 x 1 (3 x 0)	Must include entire boney pelvis	

* Anorectal musculature – delete HASTE IR Cor, center at anorectal region, all series 3x0mm, review with pedi rad

Pelvis: SCFE (slipped capital epiphysis)

- With empty bladder

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Ax T2 FS Ax (or STIR Ax)	~200 (minimum FOV to include entire boney pelvis)	5 x 1 ~32 slices		
T1 Cor STIR Cor	~200 (minimum FOV to include entire boney pelvis)	4 x 0 ~24 slice		
T1 Sag	~200 (minimum FOV to include entire boney pelvis)	6 x 1 ~25 slices		

Use thinner slices on smaller patients

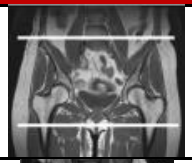
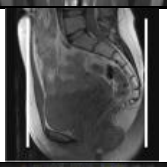
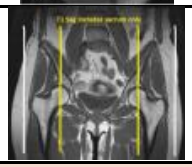
Pelvis

(inguinal hernia, coccyx or sacrococcygeal, hip for AVN)

Use Pedi protocol for 0-17 y/o or small adults

Prep:
- Empty bladder

Position:
- Tape or strap feet with internal rotation
- Legs need to be as flat as possible
- Include the include entire boney pelvis & hamstring attachment on the ischial tuberosity on all sequences Tech Notes: Document patient's inability to internally rotate

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Ax T2 FS Ax (STIR for Espree)	~300 (minimum FOV to include entire boney pelvis)	3.5 x 1 ~42 slices	Parallel to the superior surfaces of the femoral heads	
T1 Cor STIR Cor	~300 (minimum FOV to include entire boney pelvis)	3 x 1 ~38 slices		
T2 FS Sag T1 Sag	~300	4 x 1.5 (include entire boney pelvis)	T2 FS Sag: include entire boney pelvis T1 Sag: only include for sacrum/coccyx fracture	
Contrast: sacroiliitis, arthritis				
T1 FS Cor Pre *Administer contrast* T1 FS Cor Post T1 FS Ax Post			Perform T2 weighted image immediately after injection to allow for contrast uptake.	
Contrast: mass *Contrast not required for metastatic disease*				
T1 FS Ax Pre *Administer contrast* T1 FS Ax Post T1 FS Cor Post			Perform T2 weighted image immediately after injection to allow for contrast uptake.	

SI Joint

(inflammatory arthritis, sacroiliitis)

(Updated 9/19/23)

SEQUENCES	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES

See adult protocol

Spine *

- If metal, repeat T1 FS without FS. Repeat T2 FS without FS instead of STIR
- Contrast is used on PRN Contrast orders if:
  - Cervical: history of cancer, myelopathy, MS, infection, abscess, or mass
  - Thoracic: history of cancer, myelopathy, MS, infection, abscess, mass, and includes previous surgery within 10 years
  - Lumbar: history of cancer, myelopathy, infection, abscess, mass, and includes previous surgery within 10 years

Scoliosis

- Add to routine protocol if exam specifically ordered for scoliosis

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
Pedi: T2 Cor		3 x 0		

Entire Spine

Whole spine in 2 or 3 segments depending on patient size

- Sagittal fully covering the vertebral bodies side to side
- Document presence of radiculopathy (i.e., Upper back pain with radiating pain in the left chest-wall for two months)
- If hardware limits the FS on post imaging, include additional non-FS series
- Contrast is beneficial for history of cancer, myelopathy, MS, infection, abscess, mass, and surgery within 10 years
- Add a Cor T2 (3 x 1) if exam is ordered for scoliosis

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Sag Total Spine Loc			Composing - Be sure to include all the vertebrae. Might have to repeat with more slices in patients with scoliosis. Must be able to count from C1-S2.	
T1 Sag T2 FS Sag	250	4 x 0 ~13 slices 512 x 256	• Upper / mid / lower as needed • Overlap at least 1 full vertebra between sections	
T1 Cor	250		• Upper / mid / lower as needed • Overlap at least 1 full vertebra between sections	
T1 Ax T2 Ax *Administer contrast, if needed*	160	4 x 2 ~48 slices	• Upper / mid / lower as needed • Overlap at least 1 full vertebra between sections	
T1 Ax Post	160			Copies to T1 Ax
T1 FS Sag Post	250			Copies to T1 Sag

Send to PACS

- Cervical – upper spine
- Thoracic – full spine localizer
- Lumbar – full spine localizer, lower spine

Lumbar Additional Scout

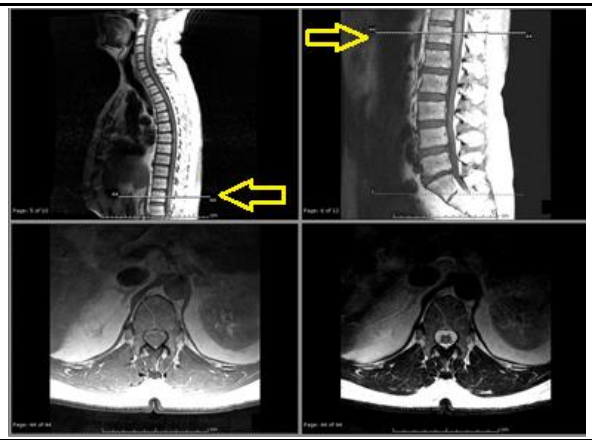
Acquire a T1 Sag loc to visualize the vertebral bodies from C2 through L1 for accurate vertebral count. This additional scout allows for accurate identification of the vertebrae especially when L5 or S1 has a transitional appearance. This is very important when patients are having interventional or surgical procedures of the spine.

- PT positioned head first supine
- Sag cervicothoracic spine scout must include skull base through L1 so that it overlaps with the T1 Sag series. Combined series including from skull base through L5-S1
- Siemens Espree: acquire the C-T spine sag scout in 2 sections with composed series
- Use an anterior sat band to improve the image quality
- If the scout images are unable to be obtained, document the reason why in the tech notes.

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Sag Total Spine Loc		256	• High bandwidth ~400 Hz to reduce edge of field artifacts	

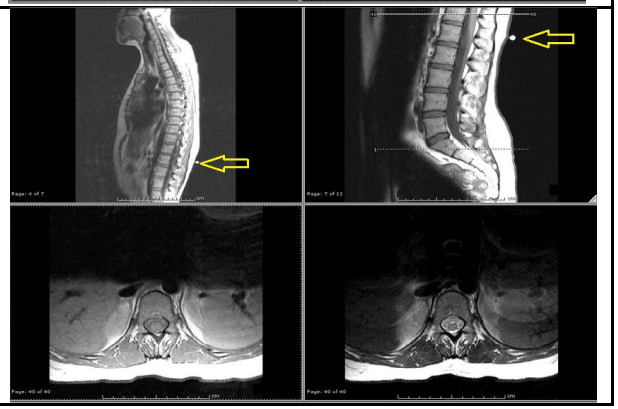
Top Row: GE, Siemens, Espree, Avanto, TIM Symphony

- Cross reference line overlaps both upper and lower loc



Siemens Symphony:

- Axial images acquired will not cross reference on sagittal series scanned at a different table location
- Place a marker at the T12 level so that it is seen on both the C-T sagittal scout and the T1 Sag series



Lumbar

- Sagittal coverage to include mid T11 to mid S3 S-I and fully covering the vertebral bodies side to side. Axials to cover from mid T12 to mid S1
- Document presence of radiculopathy (i.e., lower back pain with left leg radiculopathy for two months)
- If hardware limits the FS on post imaging, include additional non-FS series
- Contrast is beneficial for history of cancer, myelopathy, infection, abscess, mass, and surgery within 10 years

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Sag Total Spine Loc			3T Auto composing-Be sure to include all the vertebrae. Might have to repeat with more slices in patients with scoliosis. Must be able to count from C1-S2.	
T1 Sag T2 Sag Stir Sag	~280	4.5 x 0.5 ~13 slices		
T1 Ax T2 Ax	180 200 (A40, SW 1.5T, SM, WLK, WMC)	4 x 1 ~42 slices		 or 
T1 Sag FS Post T1 Sag Post (if hardware is present)	~260	4.5 x 0.5		Copies slices to T1 Sag
T1 Ax Post	180	4 X 1		Copies slices to T2 Ax

- Send coronal localizer for scoliosis, if not performing T2 Cor

Sacral Dimple

(Updated 3/23/21)

- Sagittal coverage to include mid T11 to mid S3 S-I and fully covering the vertebral bodies side to side. Axials to cover from mid T12 to mid S1
- Place markers at site of dimple & superior gluteal fold, scan through both markers, identify markers in Tech Notes

SEQUENCE	FOV (mm)	SLICE (mm)	COMMENTS	IMAGES
T1 Sag Total Spine Loc			3T Auto composing, include all the vertebrae. Repeat with more slices in patients with scoliosis. Must be able to count from C1-S2.	
T1 Sag T2 Sag T2 FS Sag (STIR)	~280	4.5 x 0.5 ~13 slices		
T1 Cor	~280	3 x 0		
T2 Ax T1 Ax	180 200 (A40, SW 1.5T, SM, WLK, WMC)	4 x 1 ~42 slices		 or 
T1 Ax Post	180	4 X 1		Copies slices to T2 Ax
T1 Sag FS Post	~260	4.5 x 0.5		Copies slices to T1 Sag