MRI PEDIATRIC PROTOCOLS
(Updated 11/1/2019)

*Please get or let us know where radiologist can review plain films.
*For Texas Orthopedics and other Docs requesting only MSK section read for their pediatric patient, please follow adult MSK section protocols unless for unusual indication or questions and then contact MSK radiologist to see if they want pediatric radiology input.
*Central Texas Pediatric Orthopedics has a separate PACS that is accessible to our radiologists. It is not necessary to request x-rays from CTPO for comparison. All that is required of the technologist is to state in their tech notes that the patient has comparison films with CTPO.

A. GENERAL INSTRUCTIONS FOR ALL MR PROTOCOLS BELOW.
1) Use No Phase Wrap / Phase Oversampling whenever possible.
2) T1 is conventional SE T1 unless specifically stated otherwise; T2’s are FSE however.
3) 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.
4) Most slice thicknesses 3-4 mm with gap of 0, .5, or 1mm unless covering a large area such as axials through pelvis or long bones, then increase slice thickness and gap as needed.
5) Use a TI of 150 for FSE IR.
6) For small joint, for high resolution PD, use 3-4 NEX.
7) Try to keep sequences 7 minutes or less (hopefully less).
8) Need for extra set for whole bone in pedi is because of skip lesions in tumor and marrow diseases.
9) Glucagon is needed for Pediatric Enterography studies.
10) Glucagon is not needed routinely for other Pediatric Abdominal and Pelvic studies but if a Female Pelvis MRI is scheduled on a teenage girl, check with a Radiologist to see if glucagon is needed.

B. Pediatric Bone (routine, tumor, infection)
Must include whole lesion extent, including edema. Review with an MSK radiologist to see if IV contrast is needed (some lesions don’t, e.g., osteochondroma) & if is small lesion unlikely to be malignant tumor; may not need large FOV’s.
1) Coil
   a) 1st large FOV whole bone – larger or body coil if needed to check for skip lesions in the bone.
   b) Then place smaller coil to cover area of interest
2) Adult long bone/joint specific protocol

C. Pedi non-tumor joint study – knee, shoulder, wrist, elbow in teenager, athlete
   Adult Protocols

D. Abbreviated Pediatric specific small joint (wrist, elbow – include for acute or chronic pain, possible bony bridge of growth plate).
1) Put joint as close to center of magnet as possible
2) Use small surface coil appropriate for size of joint
3) Adult joint specific protocol
E. Pedi Joint for Arthritis, Synovial Derangement (chronic JRA) *Only perform if specifically requests pedi rad to read
1) Appropriate extremity coil for joint.
2) Base sequences.
   a) T2 FSE FS Axial
   b) T1 FSE Cor
   c) T2 FSE FS Cor
   d) T2 FSE FS Sag or STIR
3) Shoulder, Elbow, Wrist, Hand, Hip, Knee, Ankle: add T1 FSE FS Cor pre
4) Feet: add T1 FSE FS Axial pre
5) Shoulder, Hip: add T1 FSE FS Axial post, T1 FSE FS Cor post
6) Elbow, Wrist, Hand, Knee, Ankle: add T1 FSE FS Sag post, T1 FSE FS Cor post
7) Feet: add T1 FSE FS Sag post, T1 FSE FS Axial post

F. Cartilage Specific Joint (congenital & developmental malformations, Blount’s disease, post-traumatic or post-infection bony bridges of growth plate).
1) Coil – appropriate for specific joint
2) Adult joint specific protocol

G. Foot
1) Coil – smallest that fits foot.
2) Adult protocol

H. Tarsal Coalition
1) Place foot in extremity coil, or both feet in head coil.
2) Adult ankle protocol

I. Pedi Shoulder for Dysplasia (e.g., dysplasia due to brachial plexus injury).
1st – Use coil to include both shoulders for 1st sequence, change to surface coil for rest.
1) Adult protocol

J. Unilateral Hip (generally over 5 years, Legg-Perthes, hip dysplasia)
1st check if radiologist wants bilateral or unilateral hip or contrast
1) Coil per patient size
2) Adult protocol

K. Bilateral Hip (generally under 5 years, AVN, hip dysplasia, SCFE)
Adult Protocol

L. Pelvic Tumor / Infection / Pain Protocol – include whole pelvis, which will include hips.
1) Appropriate coil for age – e.g., head coil in very young, torso in larger, etc. – center between symphysis and anterior superior iliac spine – if area of interest is buttocks, please scan prone.
2) Sequences.
   a) T1 Cor
   b) Fast IR Cor
   c) Fast IR Sag
   d) T2 FSE FS Sag
   e) T1 FS Cor post & T1 FS Axial post
M. Dermatomyositis evaluation – Image bilateral pelvis through thighs.

1) Body coil for larger children, head coil or torso coil for smaller – scan large FOV, are mapping edema, not looking for fine detail. Do not scan these sequences in segments. In order to obtain accurate measurements, the FOV of the Coronal sequences must include the entire area of interest. Do not split the Coronal sequences into an upper and lower section and then combine them. The Axial sequence needs to be scanned in a single sequence also. Depending on the size of the child, they may not be able to have this exam performed on an Espree.

2) Sequences.
   a) T1 Cor
   b) Fast IR Cor
   c) T2 FSE FS Axial (Increase slice thickness and spacing as needed)

N. Vascular mass / birthmark

1) Coil depends on extent of lesion.
2) Sequences.
   a) T1 Axial
   b) GRE Axial
   c) T1 Cor (if pathology is medial or lateral)
   d) T1 Sag (if pathology is anterior or posterior)
   e) T2 FS Axial (change to STIR if fat sat is poor)
   f) T2 FS Cor (change to STIR if fat sat is poor)
   g) T2 FS Sag (change to STIR if fat sat is poor)
   h) T1 FS Axial
   i) MR Contrast Angiogram if first study or if AVM (1 arterial and 3 venous phases)
   j) T1 FS Axial post
   k) T1 FS Cor post
   l) T1 FS Sag post

O. MSK Pelvis (Includes for diagnosis of imperforate anus)

1) Head coil for infant, torso coil for older – if for anorectal musculature, delete Fast IR Coronal, center at anorectal area and use 3mm slices with 0mm gap – check with pediatric radiologist.
2) Sequences.
   a) Fast IR Cor
   b) T1 Cor
   c) T1 Axial
   d) T2 FSE FS Axial
   e) T2 FSE Cor
   f) T2 FSE Sag

O2. Female Pelvis (Primary Amenorrhea & other gynecologic symptoms)

1) Adult Mullerian Duct protocol.
2) With exception of ovarian or pelvic tumor, a female pelvis for gynecologic symptoms are always a mullerian duct protocol.
3) For case by case clarification contact appropriate pediatric radiologist.
P. Pediatric Body Tumor.
1) Coil per patient size – infant head or extremity, child torso coil.
2) Sequences.
   a) Fast IR Cor
   b) Fast IR Sag
   c) T1 Cor
   d) T2 FSE FS Axial
   e) T1 GRE Axial (out of phase)
   f) T1 FS Cor post
   g) T1 FS Axial post

Q. Pediatric Renal Study.
1) Torso coil if small infant, can use head coil.
2) Sequences.
   a) T1 Axial
   b) T2 FSE FS Axial
   c) Fast IR Cor
   d) Post Contrast
      i) If for pyelo:
         (1) T2 FSE FS Cor post
         (2) Fast IR Cor (TE 20)
         (3) T1 FS Axial
      ii) If for tumor, nephroblastomatosis:
         (1) T1 FS Axial
         (2) T1 FS Cor
   e) MR Urogram post contrast.
      i) 3D T1 weighted SPGR (70 degree flip angle, 2 - 2.5mm thick, overlap 1mm, in coronal plane, with fat sat, kidneys to bladder, with large FOV).
      ii) Recon as MIP parallel to long axis of body and display in 15 degree increments sent to PACS.

R. Pediatric Liver
1) Perform exam with patient holding their breath if possible. If not, use free breathing sequences.
   a) T1 Cor
   b) T2 Fat Sat Cor
   c) T1 Axial (In and Out of Phase)
   d) T2 FS Axial.
   e) Heavy T2 Axial.
   f) T1 FS 3D (vibe/lava) Axial pre
   g) T1 FS 3D Axial (vibe/lava) post
      i) Immediate post
      ii) 2 minute post
      iii) 5 minute post
      iv) 10 minute post

S. Routine Abdomen
1) T1 Cor
2) T2 FS Cor (HASTE / SSFSE if needed)
3) T1 Axial
4) T2 FS Axial (HASTE / SSFSE if needed)
5) T1 FS Axial post
6) T1 FS Cor post
S2. ABDOMEN HEMACHROMATOSIS WITHOUT CONTRAST
See ACC 27084698

Axial:
(1) Out: GRE 120 / 2 / 20°
(1) In: GRE 120 / 4 / 20°
(2) In: GRE 120 / 9 / 20° (T2)
(3) In: GRE 120 / 14 / 20° (T2*)
(4) In: GRE 120 / 19 / 20° (T2**) 

Coronal:
(5) Out: GRE 120 / 2 / 20°
(5) In: GRE 120 / 4 / 20°
(6) T2 TRUFI

Axial: if time permits
(7) In: GRE 120/ 4 / 90°

NOTE:
• Coil: Body, auto-selection off
• Sequence: GRE
• Options: No fat saturation
• Bandwidth: Adapt it to get the correct TEs N excitations: 1
• Thickness: 7 or 8 mm
• Gap: Could be large (10 mm) if you have a small number of slice matrix, asymmetric to reduce acquisition time, ex: 128 x 116
• Phase: A>P
• FOV (cm): 40, may adjust base on patient’s size, but make sure the TR/TE are adjusted
• Acquisition time: approx. 15 sec.

NOTE: Example ACC 27084698
S3. UROGRAM

1) Pre Scan
   a) Patient arrives 1 hour prior to table time. IV and catheter placed.
   b) Ringer Lactate IV, total dose 10ml/Kg at approximately 1 liter/hour rate, 30-40 minutes prior to imaging.
   c) PT positioned on table, immediately inject Lasix 1mg/Kg, max dose 20mg over 2 minutes, approximately 15 minutes prior to contrast injection.

Include upper pole of kidneys to the perineum.

2) Localizer & Free breathing localizer

3) T2 Trufi Axial

4) T2 FS Trufi Axial

5) T2 Haste Axial

6) T2 Trufi Cor (5x1.5mm, angle along aorta/ureters for true coronal)

7) T2 Haste Cor

8) T1 Vibe Cor (2.5mm)

9) T2 Space Cor trigger

10) T1 FS Vibe Cor (dynamic, 25 measurements, inject contrast after 1st measurement at .5ml/sec)

11) T1 FS Vibe Axial post

12) T1 FS Vibe Cor post (dynamic, 6 measurements, free breathing)

13) T1 FS Vibe Axial post delay

14) T1 FS Vibe Cor post delay

15) T1 FS Vibe Axial post delay

16) T1 FS Vibe Sag post delay

NOTE:

- Example ACC 22702387
- Create RT Lateral, LT Lateral MPRs & Bilateral Lateral MIP from T2 Space Coronal.

T. TMJ (JRA)

1) Adult protocol

2) Add Bilateral T1 FS Sag post (closed mouth)

3) Add Bilateral T1 FS Cor post (closed mouth)

4) Add Bilateral Straight T1 FS Cor post (closed mouth)
U. Entire Spine done in 2 sections.
1) Maximum FOV Sagittal localizer with sufficient signal and resolution for counting the Cervical, Thoracic, and Lumbar spine. If the child is too large to obtain a Sagittal localizer that includes the Cervical, Thoracic, and Lumbar spine in full, the “Entire Spine” study must be done in 3 sections, not 2.
2) Upper half of spine as follows:
   a) T1 Sag 250mm FOV.
   b) T2 FS Sag 250mm FOV.
   c) T1 Cor
   d) T1 Axial
   e) T2 Axial
   f) If giving patient contrast.
      i) T1 Axial post
      ii) T1 FS Sag post (250mm FOV)
3) Lower half of spine as follows:
   a) T1 Sag (250mm FOV)
   b) T2 FS Sag (250mm FOV)
   c) T1 Cor
   d) T1 Axial
   e) T2 Axial
   f) If giving patient contrast.
      i) T1 Axial post
      ii) T1 FS Sag post (250mm FOV)

- Entire spine sequences must be sent to PACS in this order:
  Cervical – upper spine
  Thoracic – full spine localizer
  Lumbar – full spine localizer and lower spine

V. SI Joints (RA, Dr. Carrasco) *Only perform if specifically requests pedi rad to read
1) These studies should be scanned as an MSK Pelvis. Do not oblique the Cor and Axial sequences.
2) T1 Axial
3) T2 FS Axial
4) T1 Cor
5) IR Cor
6) T1 Sag
7) T1 FS Axial pre
8) T1 FS Axial post
9) T1 FS Cor post

X. Orthopedic cases for Dr. Yandow.
1) Dr. Yandow will provide notes detailing how she wants each patient to be scanned. Her notes will request that the patient be scanned with specific parameters including but not limited to: FOV, sequence weighting, scan plane, slice thickness, slice spacing, and matrix. Consult with the Pedi Radiologist on each of these cases in order to determine how to integrate Dr. Yandow’s order with our standard protocols. Scan Dr. Yandow’s notes into synapse so that the radiologist will have access to them when reading the case. If Dr. Yandow orders a bilateral study (femur, tib-fib, etc.) and the Coronal sequences include both sides, be sure to send the Coronal sequences to both folders in Synapse.
**Y. Brain Routine** Run the Adult Protocol that applies to the patient’s diagnosis.
1) Add T1 Axial pre if child is 9 or below or has pathology
2) Replace T1 Sag with T1 SPGR / MPRAGE Sagittal (for DX of developmental delay)
   a) Reformat into Axial and Coronal planes.

**Y2. Brain Non Contrast**
1) T1 3D Sag (reformat into Axial and Coronal planes with 3mm slices)
2) Diffusion Axial
3) FLAIR Axial
4) T2 FS Axial
5) T2 FS Cor
6) GRE Cor

**Y3. Brain Other** Run the Adult Protocol that applies to the patient’s diagnosis.

**Z. LUMBAR (sacral dimple)**
1) T1 Sag
2) T2 Fat Sat Sag
3) T1 Cor
4) T1 Axial
5) T2 Axial
6) T1 Axial post
7) T1 FS Sag post

Place one marker at the site of the dimple and another marker at the Superior Gluteal Fold. Scan through both markers on all sequences.

*It is very important to state in your tech notes which marker is located at the site of the dimple.*

**AA. LUMBAR**
1) T1 Sag
2) T2 Sag
3) STIR Sag
4) T1 Axial
5) T2 Axial

**AB. SPINE (scoliosis or vertebral anomalies)**
1) Adult specific protocol
2) Add T2 Cor

**CC. Whole Body (CRMO, oncology screening such as p53 mutation)**
- CRMO: without contrast
- Oncology Screening: with & without contrast
1) STIR Cor
2) T1 Cor
3) T2 FS Axial
4) For CRMO add
   5) STIR Sag of spine
5) For Oncology add
   7) T1 FS Cor post