IPSG protocol for contrast subtraction (perfusion) MRI v8
Imaging subgroup
Last Updated, December 2018

All patients enrolled in the IPSG study need a perfusion MRI according to this protocol:

Pre-contrast *(coronal plane for both hips; sagittal plane for affected hip)*	**Duration***
COR FSE T1	3 min
COR FSE T2 with fat sat	4 min
COR FSE T1 with fat sat	4-5 min
SAG T1 with fat sat (only affected hip)	5-6 min
AXIAL FSE T2 (optional)	4 min
Injection of contrast: Dotarem (gadoterate meglumine) 0.2ml/kg (0.5mmol/ml), may use other macrocyclic gado agents	
COR and SAG FSE T1 with fat sat AT 2 MINUTES POST-INJECTION	9- 11 min
Subtraction images MUST be included	
COR and SAG **Post-contrast** FSE T1 FS **minus PRE-Contrast** FSE T1 FS	Post scan

*Duration will vary depending on patient cooperation. In addition, 5 minutes should be added after the completion of the pre-contrast sequences for a radiologist to check the images prior to performing the contrast sequences.

IPSG
INTERNATIONAL PERTHES STUDY GROUP

PERFUSION MRI FAQs for Radiology Teams

Which scans are acquired?

1. COR T1 FSE
2. COR T2 FSE FS
3. COR T1 FSE FS
4. SAG T1 FSE FS
5. COR T1 FSE FS w/Contrast
6. SAG T1 FSE FS w/Contrast

All other scans are optional. See Appendix II for examples.

What is the field of view?

Coronal Images should be done at the smallest FOV to include the pelvis and both hips through the level of the lesser trochanters. Slices should only include bony anatomy, NOT skin to skin. This is very important to reduce the acquisition time and potential patient motion Typically, about 20 slices are collected and are done in one acquisition without the need for concatenation. Please share this with your technologist. Sagittal images are done at a FOV of 18.

How thick are the slices? Is any skip used?

Slices are 4mm skip 0.

When is the contrast given?

Contrast is injected after scans of Cor FSE T1, Cor FSE T2 FS, Cor FSE T1 FS, and Sag FSE T1 FS of the affected hip. Other scans (STIR, Axial FSE T2) are not required as part of IPSG protocol.

What is the recommended contrast agent?

DOTAREM. Any FDA approved gadolinium agent can be administered intravenously as per your department's protocol. The dose is 0.2 ml/kg (0.5mmol/ml). We at TSRH use Dotarem, a macrocyclic ionic agent, to reduce the likelihood of soft tissue deposition of free Gd +3.

How long after injection are the contrast images acquired?

We at TSRH image the patient at two minutes post the initiation of hand contrast injection. We do not use a power injector, however, power injection is acceptable. If the radiologist requests a dynamic post contrast scan, then the fat suppressed coronal T1 weighted images should follow the dynamic scan (such as TRICKS) without further delay.

What type of gadolinium should be used?

Any FDA approved gadolinium contrast agent.

What dose of gadolinium should be used?

0.2 ml/kg (0.5 mmol/ml). The maximum dose administered is 20 ml.

What is the subtraction image?

The subtraction image is the fat suppressed *Post*-contrast T1 FSE sequence ***minus*** the fat suppressed *Pre*-contrast T1 FSE sequence. The pre-contrast fat suppressed images serve as a mask.

What other data should be collected?

Please note any adverse events or if the child required sedation, GA, video goggles or other distraction.

PERFUSION MRI FAQs for Research Teams

Why is this protocol being done?
The subtracted images delineate perfusion patterns of the capital femoral epiphysis, metaphysis and physis and can be analysed to establish what percentage of the epiphysis is viable early on in the course of the disease.

Which patients should get a perfusion MRI?
Scans should be obtained *as soon as possible after presentation* with Perthes disease, ideally in the initial or early fragmentation stages, in children aged 6-12 years.

What other data should be collected with the perfusion MRI?
Standard SUPINE AP pelvis and frog-lateral supine films taken at initial presentation, 4, 8, and 12 months, 2 years and 5 years should be provided for subsequent analysis of Herring grade, Deformity Index and Stulberg grade by the IPSG imaging subgroup.

Who should I send the perfusion MRI CD to?
Please mail de-identified, coded MRIs on CD with the participant's REDCap Study ID to:
Texas Scottish Rite Hospital for Children
ATTN: IPSG Coordinator
DEPT: Orthopaedic Research
2222 Welborn St.
Dallas TX, 75219

Who should I contact for further questions?
Please contact these individuals if you have problems or questions:

- IPSG Research Coordinators : IPSG@tsrh.org
- Victoria Vlasek (MRI Lead Technologist): victoria.vlasek@tsrh.org, 214-559-7450, ext. 6198

How safe is perfusion MRI?
Because Gadolinium (Gd+3) as a free agent is toxic it is chelated to various chelates such as DOTA or DTPA in the various contrast agents available on the market today. The chelated complex is excreted by the kidneys so renal function should be normal in children undergoing this investigation. A history of allergy should also be sought. Most chelates are stable with a wide safety margin at appropriate doses. Recent studies have reported gadolinium deposition in various soft tissues, such as brain, following repeated administration of GBCA's. The clinical significance is unknown, but to date the available literature suggests the likelihood of Gd3+ deposition is reduced with a macrocyclic agent such as Dotarem (gadoterate meglumine) or Prohance (gadoteridol). These agents are among those with the highest chelate stability. All agents are similar for their risk of minor adverse reactions (taste alteration, nausea, hives). Spurious hypocalacemia has been reported with some agents, but not gadoteridol or gadoterate. Nephrogenic systemic fibrosis (NSF) is reported in association with gadolinium given to patients with renal failure (3% rate when GFR<30). There is a 5% fatality rate and it is incurable. There are 5 reported associations between gadolinium and NSF in children under 18 years of age; all had chronic kidney disease and only one had a definite history of Gadolinium exposure. Overall the adverse event rate in adults is 0.01% (9% of this severe) over 15 years and 45 million administrations. Data for young children is less abundant; gadolinium should therefore be given on a case by case basis with appropriate discussion of risks and benefits.

Appendix I

Protocol: Hip Perthes

Date last modified: December 18, 2018

Position/ Coil: Cardiac Coil

Author: MED

Injector:

Estimated Time:

Notes:

Plane	Sequence	FS	TR / TE (msec)	ETL	TI (msec)	FOV (cm)	Matrix	Slice/Gap	NEX	Other Imaging Parameters / Duration of sequence
3 Plane Loc	FGRE		5.3/1.6			36	256/128	5/0	2	NPW Time :23 Sec
Coronal	T1 FSE XL	---	400/Min Full	3	-----	24	416/224	4/0	3	FC/TRF/Fast/ BW 35.71 Time 3 Min
Coronal	T2 FRFSE XL	FS	3900/68	15	-----	24	352/224	4/0	4	FC/TRF/Fast/FR/BW 31.25 Time 4 Min
Coronal	T1 FSE XL	FS	600/Min Full	3	-----	24	320/224	4/0	3	FC/TRF/Fast/BW 31.25 Time 4-5 Min
Sag	T1 FSE XL	FS	600/Min Full	3	-----	18	320/224	4/0	3	FC/TRF/Fast BW 31.25 Time 5-6 Min
Axial	T2 FRFSE XL	---	3500/68	15	----	24	352/224	4/0	4	FC/TRF/Fast/FR BW 31.25 Time 4
Post Contrast										Repeat Coronal T1 FS and Sag T1 FS with contrast 2 minutes post-gadolinium injection and do subtraction Time 9-11

Appendix II

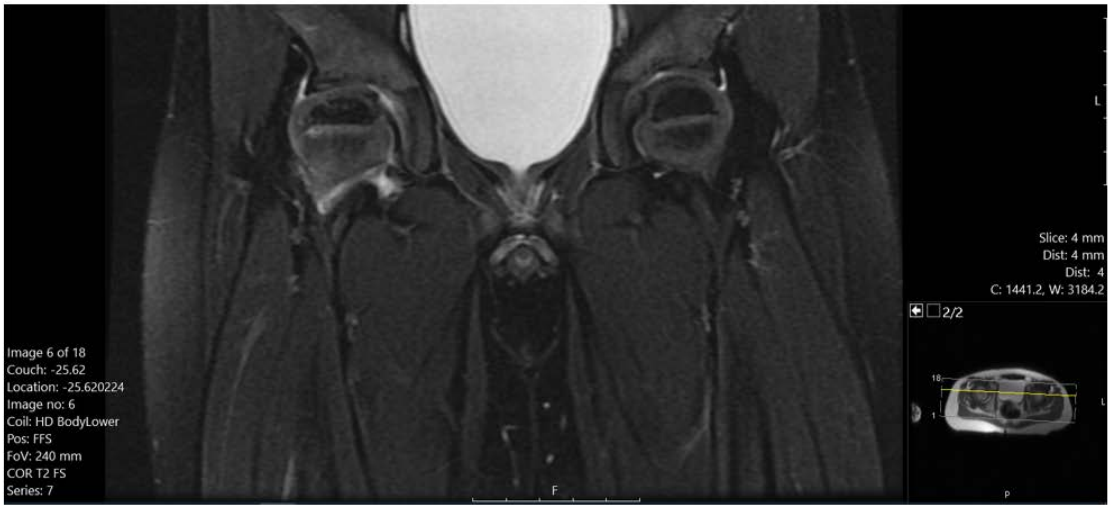
COR FSE T1

Precontrast	
COR FSE T1	3 min

COR T2 FSE FS

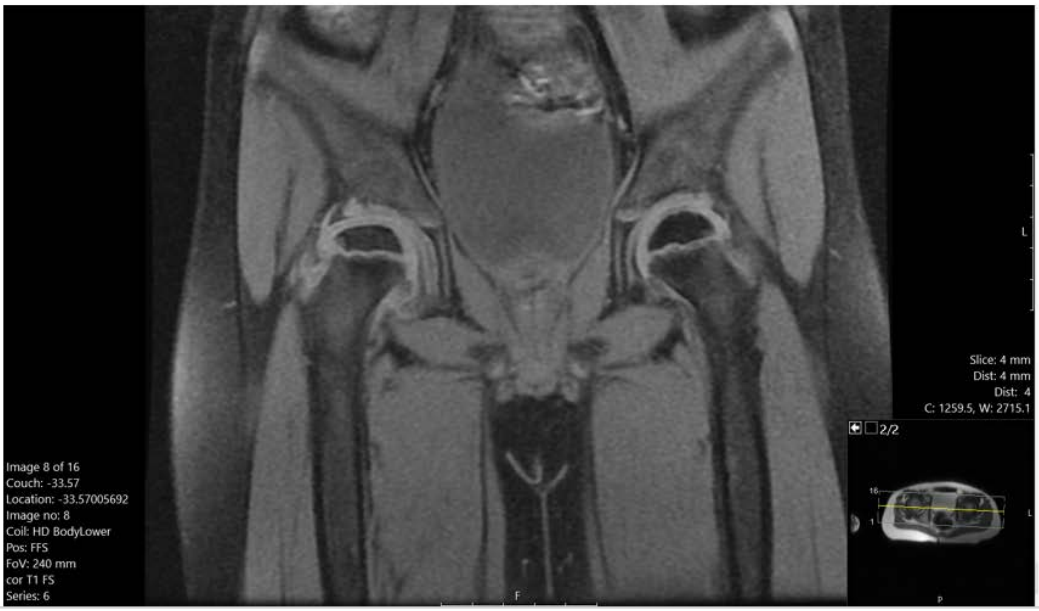
Precontrast	
COR FSE T2 with fat sat	4 min

- **Note:** Fluid sensitive sequence is a fast spin echo T2 with fat suppression. **Not STIR**



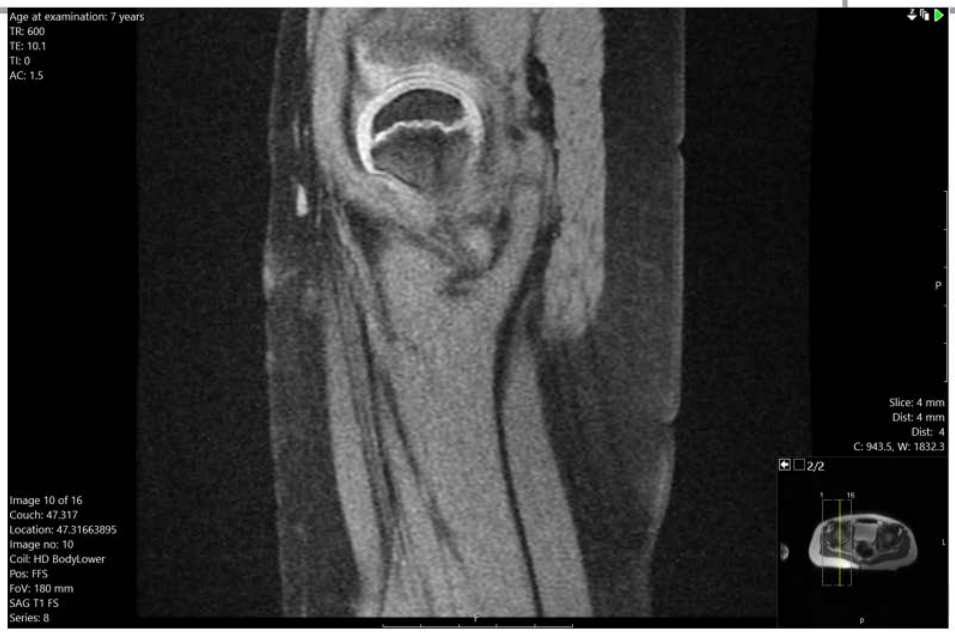
COR T1 FSE FS

Precontrast	
COR FSE T1 with fat sat	4-5 min



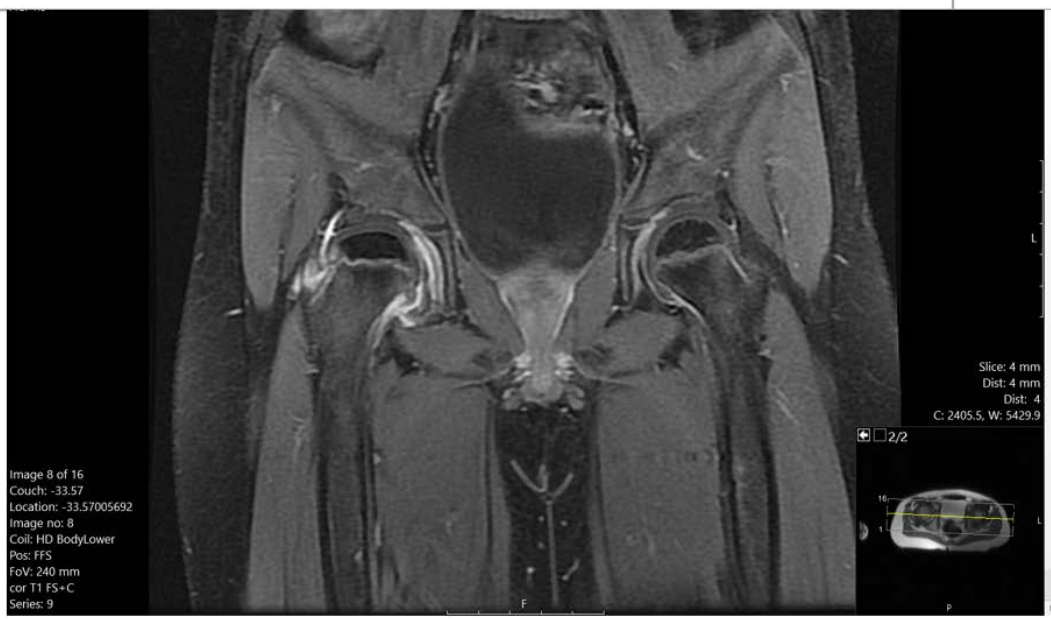
SAG T1 FS FSE

Precontrast	
SAG T1 with fat sat (only affected hip)	5-6 min



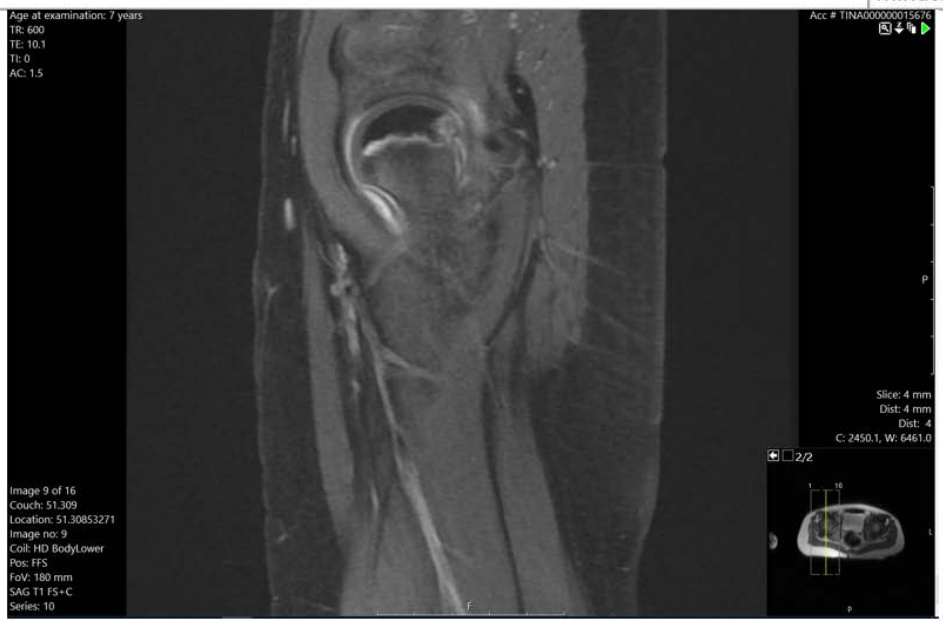
COR T1 FS FSE CONTRAST

Injection of contrast	**(Dotarem (0.2 mL/kg (0.5mmol/mL))**
COR and SAG FSE T1 with fat sat (at 2 mins post injection	9 - 11 minutes

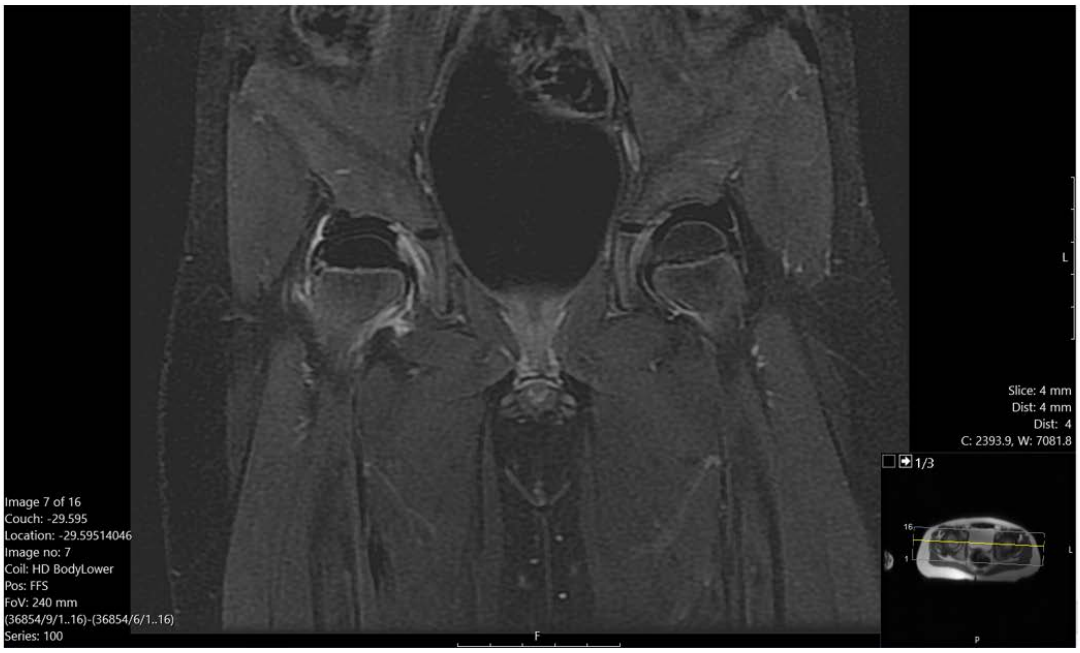


SAG T1 FS FSE CONTRAST

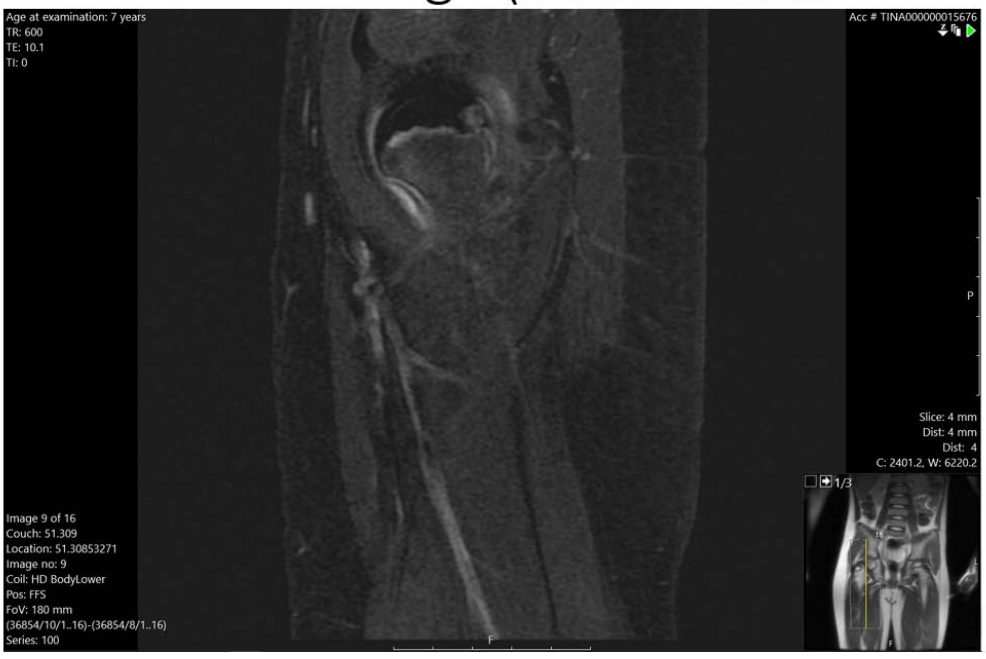
Injection of contrast	**(Dotarem (0.2 mL/kg (0.5mmol/mL))**
COR and SAG FSE T1 with fat sat (at 2 mins post injection	9 - 11 minutes



COR Subtraction Image (POST – PRE T1 FSE FS)



SAG Subtraction image (POST – PRE T1 FSE FS)



INTERNATIONAL PERTHES STUDY GROUP

Appendix III

Protocol Name/Scanner/Protocol Number: Pelvis for Legg Perthes, For GE Signa HDxt 1.5 T

	SERIES DESCRIPTION	COR T1 FSE Bilat hips	COR T2 FRFSE FS Bilat hips	COR T1 FSE FS Bilat hips	SAG T1 FSE FS (of the effected side)	COR T1 FSE FS Bilat hips	SAG T1 FSE FS (of the effected side)
PATIENT POSITION	Patient Position	Supine					
	Patient Orientation	Feet First					
	Coil Type	Cardiac					
SCAN RANGE	Field of View	~24 cm	~24 cm	~24 cm	18	~24 cm	18
	Slice Thickness	4	4	4	4	4	4
	Slice Spacing	0	0	0	0	0	0
SCAN TIMING	TE	Min full	68	Min full	Min full	Min full	Min full
	TR	400-700	3500-6000	400-700	400-700	400-700	400-700
	Echo Train Length	3	~15	3	3	3	3
	Bandwidth	35.71	31.25	31.25	25	31.25	25
	Flip Angle						
ACQ TIMING	Freq	416	352	320	320	320	320
	Phase	224	224	224	224	224	224
	Freq DIR	S/I	S/I	S/I	S/I	S/I	S/I
	NEX	3	4	3	3	3	3
	Flow Comp Direction	Freq	Freq	Freq	Freq	Freq	Freq
	Phase FOV	1	1	1	0.90	1	0.90
	Contrast					Yes	Yes
	Subtraction			Yes	Yes	Yes	Yes

IPSG
INTERNATIONAL PERTHES STUDY GROUP