

## Cardiac MRI Fontan Studies Template

This template is designed to provide a structured framework for reporting cardiac MRI Fontan studies, based on the SCMR Reporting guidelines (JCMR 2024; 26(2):101062).

### Section I: General Information:

#### Administrative:

Site ID: ()

Site of Service: inpatient hospital, outpatient facility, free standing imaging center, ambulatory care office, or mobile unit, other (drop down and free text)

Scanner: Manufacturer, Field strength (Drop down and free text)

#### Demographics:

##### Patient Identifiers:

Patient's full name,

Date of birth, age

Medical record number

##### Scheduling and performance of study

1. Date of procedure ()
2. Primary indication for test ()
3. Referring physician
4. Study quality (Drop down), reasons for suboptimal study
5. Technologist
6. Reporting physician

##### History and risk factors – (pulled directly from EMR)

1. Height
2. Weight
3. BSA, formula used (drop down)
4. Oxygen saturation
5. Blood pressure
6. **Clinical Indication for the Study:** State the clinical reason for performing the cardiac MRI study. **Optional: Other Relevant Investigations:** Relevant cardiac investigations, such as electrocardiogram (ECG), echocardiography reports, or nuclear imaging results

##### Non-imaging findings associated with examinations:

1. Contrast agent
  - a. Name,



- b. Dose, and
  - c. Administrative route (default to IV)
2. Sedation (none, conscious sedation, GETA with/without apnea)
3. Additional medications and indication (dobutamine, isoproterenol, lidocaine), dose, drip/bolus
4. Acquisition (breath-held, free breathing)
5. Limitations/complications

## Section II: General Techniques:

### Listing of sequences used (drop down to pick and choose)

- i. Cine
- ii. Velocity-encoded / phase contrast cine
- iii. FSE/black blood imaging\*
- iv. MR contrast angiography vs 3D whole heart sequence (SSFP/GRE)
- v. Tagged and other strain-encoding cine\*
- vi. T1- and T2-weighted imaging (T1w; T2w)\*
- vii. Quantitative T1 and T2 mapping\*
- viii. Myocardial perfusion\*
- ix. Late gadolinium enhancement\*
- x. 4D flow imaging\*

\*As needed clinically/with IV placement

**Method of acquisition:** Study was performed using above listed sequences with imaging in short axis, long axis, outflow tract orthogonal planes using 2D/ 3D data sets.

Software used to analyze the study:

## Section III: Findings:

### Initial congenital anatomy:

**Free text** (examples: HLHS (M[A/S]/A[A/S]), AV canal (balance, dominance), Tricuspid atresia with normally related/transposed great arteries, DILV, DIRV, Pulmonary atresia with intact ventricular septum, etc)

Surgical interventions:

### Situs, segmental anatomy:

*Visceral situs:*

*I. Solitus*

*II. Inversus*

*III. Ambiguous*

*Cardiac position (drop down to pick and choose):*

*I. Levocardia*



- II. Mesocardia
- III. Dextrocardia
- IV. Dextroposition

*Apex position (drop down to pick and choose):*

- I. Leftward
- II. Midline
- III. Rightward
- IV. Dextroposition

*Great artery position (aorta relative to PA, drop down to pick and choose):*

- I. Normal
- II. Aorta rightward
- III. Aorta leftward
- IV. Aorta anterior
- V. Aorta posterior
- VI. Side-by-side, aorta rightward
- VII. Side-by-side, aorta leftward

*Segmental (drop down to pick and choose):*

Atrial: S, I, A, X

Ventricular: D, L, X

Great artery: S, D, L, I, X

*Concordance (drop down to pick and choose):*

AV: Concordant, discordant, concordant after repair

VA: Concordant, discordant, concordant after surgical repair

Heterotaxy: None, left atrial isomerism, right atrial isomerism

**Systemic venous anatomy:**

SVC: right sided, left sided, bilateral

IVC: Right sided, left sided, interrupted with azygos continuation

Innominate vein: Present, absent, small

Glenn anastomosis: right sided, left sided, bilateral

Glenn obstruction: Patent, obstructed, unobstructed

Fontan anastomosis: Extracardiac, lateral tunnel, intra-extra cardiac

Fontan obstruction: non, present, location

Fenestration: present, absent, device closed, stented

Fenestration size: Small, medium, large



Baffle leaks: Yes, no

**Pulmonary venous anatomy:**

Type out: Normal to left atrium, TAPVR to (innominate vein, SVC, IVC, coronary sinus, etc), PAPVR of (specific veins) to (cardiac structure), Ipsilateral veins (right to RA, left to LA)

Pulmonary vein stenosis/narrowing: Present (specific veins), absent

**Atrium:**

Right atrium: dilated (mild, moderate, severe), normal

Left atrium: dilated (mild, moderate, severe), normal

Atrial appendages: Normal, juxtaposition to left/right, bilateral right, bilateral left

Atrial communication: size (small, moderate, large), obstruction

**AV valves:**

Mitral Valve: Hypoplastic, Atretic, Normal/increased thickness, Normal/decreased mobility, No/mild/moderate/ severe regurgitation visually. No stenosis visually

Tricuspid Valve: Hypoplastic, atretic, Normal/increased thickness, Normal/decreased mobility, No/mild/moderate/ severe regurgitation visually. No stenosis visually

**Optional free text**

**Left ventricle:**

Drop down:

Size: Hypoplastic, Normal, Dilated, degree of dilation - (drop down to pick and choose)

Wall thickness: Thin, Normal, Hypertrophied - (drop down to pick and choose)

Systolic function: Normal, Decreased, Mildly decreased, Moderately decreased, Severely decreased. (drop down to pick and choose)

Aneurysms: If present, should be defined as true or false and described further

Regional wall motion: septal flattening, described qualitatively especially in relation to the septum

**Right ventricle:**

Size: Hypoplastic, Normal, Dilated, degree of dilation - (drop down to pick and choose). RV:LV volume ratio

Wall thickness: Thin, Normal, Hypertrophied



Systolic function: Normal, Decreased, Mildly decreased, Moderately decreased, Severely decreased. (drop down to pick and choose)

Aneurysms: If present, should be defined as true or false and described further

### **Ventricular septum:**

VSDs: No VSD, VSD + location, VSD size, additional VSDs

**Valves:** - (drop down to pick and choose)

Neo-Aortic Valve: Tricuspid/ Bicuspid/ functionally bicuspid/ other/unknown, Normal/increased thickness, Normal/decreased mobility, No/mild/moderate/ severe regurgitation visually, degree of regurgitation (RF% by PC, volumetric analysis if able). No stenosis visually

Neo-Pulmonic Valve: Presence/absence, Normal/increased thickness, Normal/decreased mobility, No/mild/moderate/ severe regurgitation visually. Degree of regurgitation (RF by PC, volumetric analysis if able). No stenosis visually

### **Outflow tracts:**

RVOT: unobstructed, obstructed, dilated

LVOT: unobstructed, obstructed, dilated

### **Pulmonary arteries:**

Branch Pulmonary Arteries:

RPA (rightward of Glenn): dilated (degree), hypoplastic (degree), absent. Discrete obstruction/narrowing (AP/lateral vs left/right), present/absent stent

LPA (leftward of left Glenn, if present): dilated (degree), hypoplastic (degree), absent. Discrete obstruction/narrowing (AP/lateral vs left/right), present/absent stent

Central PA (between Glenns, if present): dilated (degree), hypoplastic (degree), absent. Discrete obstruction/narrowing (AP/lateral vs left/right), present/absent stent

Flow differential: QpR:QpL (PA flows): x:y%, QpRPV:QpLPV (pulmonary vein flows): x:y%

### **Aorta:**

*If Damus–Kaye–Stansel(DKS) anastomosis:*

Native aortic valve: size (mildly, moderately, severely hypoplastic, atretic), bicuspid/trileaflet, thickening

Degree of native aortic regurgitation: mild, mild to moderate, moderate, moderate to severe, severe

Native aortic root: size (mildly, moderately, severely hypoplastic, atretic)

Native ascending aorta (mildly, moderately, severely hypoplastic, atretic)

DKS anastomosis: Narrowed, not narrowed, dephasing artifact

Neo-Aortic root: Normal, dilated, hypoplastic

Degree of neo-aortic regurgitation: mild, mild to moderate, moderate, moderate to severe, severe

Ascending aorta distal to DKS: Normal, dilated (degree), hypoplastic (degree)

Arch branching pattern: Left, left normal branching, left aberrant subclavian, right, right mirror image branching, right aberrant subclavian

Arch appearance: Dilated, hypoplastic, coarctation (degree, location)

*If no Damus–Kaye–Stansel(DKS):*

Degree of aortic regurgitation: mild, mild to moderate, moderate, moderate to severe, severe

Aortic root: Normal, dilated, hypoplastic

Aortic anastomosis: Narrowed, not narrowed, dephasing artifact

Ascending aorta: Normal, dilated (degree), hypoplastic (degree)

Arch branching pattern: Left, left normal branching, left aberrant subclavian, right, right mirror image branching, right aberrant subclavian

Arch appearance: Dilated, hypoplastic, coarctation (degree, location)

Visible collaterals: None, small, large, location

### **Coronary arteries:**

RCA following re-implantation: Origin, course, proximal obstruction

LCA following re-implantation: origin, course, proximal obstruction

L circumflex: origin (from RCA vs LCA), course

**Pericardium:** (drop down to pick and choose)

Thickness – normal/ increased

Effusion – None/ trivial/ small/ moderate/ large

Pleural effusion: (drop down to pick and choose)

Present/ Absent

If Present,

Size: Trivial/ Small/ Moderate/ Large

Location: Right/ Left

### **Qp:Qs**

Qp:Qs is x:1 based on (great artery flow, volumetric analysis, venous return)

**Myocardial Perfusion:** Evidence/no evidence of perfusion defects on first pass perfusion, location (if present)

**Late gadolinium enhancement (LGE):** (drop down to pick and choose)

**Late gadolinium enhancement imaging of the myocardium is normal. No evidence of scar, infiltration or infarction.**

**(Or)**

**Late gadolinium enhancement imaging of the myocardium is abnormal.**

Subepicardial/ intramural/ subendocardial/ transmural enhancement is present, involving (i.  $\leq 25\%$  ii.  $26\%$  to  $\leq 50\%$  iii.  $51\%$  to  $\leq 75\%$  iv.  $76\%$  to  $100\%$ ) of the transmural thickness in the (segments) in Location: Reference location of segments for LV and RV.

Total mass of LGE tissue (optional): grams (g) and ( ) percentage relative to the total myocardial mass.

**Advanced tissue characterization if performed: (drop down)**

- i. Global or regional native myocardial T2\*: decreased/ normal value
- ii. Global or regional native myocardial T1: increased/ decreased/ normal value
- iii. Global or regional native myocardial T2: increased/ decreased/ normal value
- iv. Global or regional ECV (extra cellular volume fraction): increased/ normal value absolute value (%)- optional

Findings are within normal limits, suggestive of myocardial iron overload, myocardial edema, infiltrative cardiomyopathy, other - (drop down to pick and choose)

V. Extra-cardiac findings : None/ Other

**Quantitative assessment:**

**Ventricular volumes (Z-scores calculated using [insert reference])**

**Heart rate (bpm)**

**Left Ventricle:**

- LV end-diastolic volume (LVEDV) (Z-score)
- LVEDV index=LVEDV/body surface area (BSA):
- LV end-systolic volume (LVESV) (Z-score):
- LVESV index=LVESV/BSA:
- LV stroke volume (LVSV):
- LV ejection fraction (LVEF):
- LV cardiac output (LVCO):
- LV cardiac index (LVCI):

- LV mass (LVM) (Z-score):
- LV mass indexed (LVM/BSA):

**Right Ventricle:**

- RV end-diastolic volume (RVEDV) (Z-score):
- RVEDV index=RVEDV/body surface area (BSA):
- RV end-systolic volume (RVESV) (Z-score):
- RVESV index=RVESV/BSA:
- RV stroke volume (RVSV):
- RV ejection fraction (RVEF):
- RV cardiac output (RVCO):
- RV cardiac index (RVCI):
- RV mass (g): (Z-score):
- RV mass indexed (g/m<sup>2</sup>):

**Common Ventricle:**

- End-diastolic volume (EDV) (Z-score):
- EDV index=EDV/body surface area (BSA):
- End-systolic volume (ESV) (Z-score):
- ESV index=ESV/BSA:
- Stroke volume (SV):
- Ejection fraction (EF):
- Cardiac output (CO):
- Cardiac index (CI):
- Mass (g) (Z-score):
- Mass indexed (g/m<sup>2</sup>):

**Cardiac flows:**

Ascending Aorta - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

Native Aorta (if DKS) - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

Neo-Aorta (if DKS) - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

Right pulmonary artery - Cardiac Output [] L/min at a heart rate of [] beats per minute



Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

Left pulmonary artery - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

Central PA (if bilateral Glenn): Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

Right SVC - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

Left SVC (if present) - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

High Fontan - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

IVC (below fenestration) - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

Descending aorta - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL Regurgitant fraction [] %

LUPV - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

LLPV - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

RUPV - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

RLPV - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL, Reverse [] mL, Net [] mL

Mitral valve - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL

Tricuspid valve - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL

Common AV valve (if CAVC) - Cardiac Output [] L/min at a heart rate of [] beats per minute

Forward [] mL

**AV valve regurgitation (if significant, PC imaging performed):**

Tricuspid valve: [] % by comparing AV valve inflow volume to the aortic net stroke volume, or [] % comparing the ventricular stroke volume to the aortic forward stroke volume.

Mitral valve: [] % by comparing AV valve inflow volume to the aortic net stroke volume, or [] % comparing the ventricular stroke volume to the aortic forward stroke volume.

**Collateral flow:**

Aortic flow: x L/min, y L/min/m<sup>2</sup>, z% of aortic flow (ascending aorta – systemic venous return/ascending aorta flow)

Pulmonary venous return: a L/min, b L/min/m<sup>2</sup>, c% of pulmonary venous return (pulmonary venous flow-pulmonary arterial flow/pulmonary venous flow)

**Fenestration flow:**

X L/min, y L/min/m<sup>2</sup> (proximal IVC-Fontan baffle below Pas)

**Measurements:** (Measurements made from the contrast MRA/non contrast MRA/cine images in (systole/diastole/unspecified)

Native-aortic valve annulus (cm): [] x [] (measurement made from MRA/cine imaging)

Neo-aortic valve annulus (cm): [] x [] (measurement made from MRA/cine imaging)

Native aorta mid-sinus(cm): [] x [] x [] (cusp to commissure), [] x [] x [] (cusp to cusp)

Neo-aorta mid-sinus(cm): [] x [] x [] (cusp to commissure), [] x [] x [] (cusp to cusp) (measurement made from MRA/cine imaging)

Ascending aorta distal to anastomosis(cm): [] X [] (anterior-posterior x right-left)

Native Ascending aorta(cm): [] X [] (anterior-posterior x right-left)

Proximal transverse arch (cm, proximal to left common carotid): [] X []

Distal transverse arch (cm); proximal to LSCA): [] X []

Aortic isthmus (cm): [] x [] (anterior-posterior x right-left)

Descending aorta at the diaphragm(cm): [] x [] (anterior-posterior x right-left)

Main pulmonary artery(cm): [] x [] (right-left x superior-inferior) proximal [] x [] (right-left x superior-inferior); mid [] x [] (right-left x superior-inferior); distal [] x [] (right-left x superior-inferior) , MPA length (annulus to bifurcation)

Right pulmonary artery(cm): Proximal [] x [] (right-left x superior-inferior) (Z-score []). Mid (between aorta/SVC): [] x [] (right-left x superior-inferior). Distal [] x [] (right-left x superior-inferior) (Z-score [])

Left pulmonary artery(cm): Proximal [] x [] (right-left x superior-inferior) (Z-score []). Mid [] x [] (right-left x superior-inferior) (Z-score [])

Central pulmonary artery(cm): [] x [] (right-left x superior-inferior) (Z-score []).

Impression:

X year old male/female/non-binary with history of xxx s/p (repair type)

1. Underlying cardiac anatomy
2. LV size/function
3. RV size/function
4. Common ventricular size/function (if applicable)
5. Description of Glenn anastomoses
6. Description of Fontan anastomoses, fenestration size, flow
7. PA appearance, flow differential
8. Collateral flow, degree, collateral appearance on MRA
9. Aorta, DKS, dilation of root/ascending aorta
10. Neo, native-aortic regurgitation/obstruction
11. Perfusion defects, if applicable
12. LGE, if applicable