Society for Cardiovascular Magnetic Resonance

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

4. **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. vii. 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.
Study was analyzed using: Medis/ Circle/ Neosoft/ Other (Drop down with free text option)

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. ≤25% ii. 26% to≤50% iii. 51% to≤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/m2):

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/m2):

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/m2, z% of aortic flow (ascending aorta – systemic venous return/ascending aorta flow)
Pulmonary venous return: a L/min, b L/min/m2, c% of pulmonary venous return (pulmonary venous flow-pulmonary arterial flow/pulmonary venous flow)

Fenestration flow:
X L/min, y L/min/m2 (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