



*Canadian Society for
Cardiovascular Magnetic Resonance*

Can SCMR CMR protocol recommendations

V1.3 - April 2009

LV function (15 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh

TC - INFLAMMATION (40 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh
5	Edema	STIR	3 short axis views	10 mm body coil options: single-shot GET2
6	Reversible injury Inflammation	T1 Early enhancement	3 short axes OR 3 long axes	15 mm PRE and starting 10 sec after bolus is completed
7	Irreversible injury Fibrosis	Late enhancement	short axis stack 3 long axes	Breath-held 3D longTI option: single slice

FIBROSIS / Viability (30 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh
5	Irreversible injury Fibrosis	Inversion-Recovery Gradient Echo ("Late Gd enhancement")	short axis stack 3 long axes	Breath-held 2D or 3D individually optimized TI optional: single slice, added short TI (fibrosis appears with low signal)

Acute MI / ACS (30 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh
5	Edema	STIR	short axis stack 3 long axes	10 mm
6	Rest perfusion	GE-EPI/T-SENSE	3 short axis then add: 4CV, 2CV, (3 CV if possible, too)	0.075 mmol/kg
7	Irreversible injury Fibrosis	Late enhancement	short axis stack 3 long axes	Breath-held 3D shortTI+longTI option: single slice

Elective stress perfusion (40-50 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh
5	Stress	GE-EPI/T-SENSE	3 short axis then add: 4CV, 2CV, (3 CV if possible, too)	0.075 mmol/kg second dose after stress
6	Coronary angio	Breath-hold 3D CMRA	proximal coronaries	navigator as alternative
7	Irreversible injury	Late enhancement	short axis stack 3 long axes	Breath-held 3D long TI + short TI
8	Rest	GE-EPI/T-SENSE	same orientation as stress perfusion	0.075 mmol/kg

Pericarditis and cardiac tumors (60 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	cine SSFP	multiple axes	Realtime
3	Septal shift during inspiration (constriction)	cine SSFP	short axis	Realtime <i>during expiration and during inspiration</i>
4	LV function	cine long axis	6 long axes in one bh 3 short axes in one bh	8-10 mm
5	Pericardial adhesion	Tagging Cine	5 short axis	10 mm match with short axis "3"
7	Pericardial inflammation	STIR or single-shot T2	3 - 5 short axis	10 mm, same orientation as sequence 4) 32-CHANNEL COIL!
8	Pericardial anatomy	SE T1	3 - 5 short axis	10 mm, same orientation as sequence 4)
9	Pericardial anatomy	SE T1 fat sat post contrast	3 - 5 short axis	10 mm, same orientation as sequence 4)
10	Irreversible injury	late enhancement	3 - 5 short axis 3 long axis	10 mm, same orientation as sequence 4)
11	Optional:	rest perfusion gradient echo cine BOLD cine Flow	adapted to tumor	further sequences, if required

Dobutamine stress function (45 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	cine SSFP	multiple axes	Realtime
3	LV function at rest	cine SSFP	6 long axes in one bh 3 short axes in one bh	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function @ 10 µg/kg	cine SSFP	6 long axes in one bh 3 short axes in one bh	dto.
5	LV function @ 20 µg/kg	cine SSFP	6 long axes in one bh 3 short axes in one bh	dto.
7	LV function @ 30 µg/kg	cine SSFP	6 long axes in one bh 3 short axes in one bh	dto.
8	LV function @ 40 µg/kg	cine SSFP	6 long axes in one bh 3 short axes in one bh	dto.
9	LV function @ 40 µg/kg plus Atropin 3 x 0.5 mg	cine SSFP	6 long axes in one bh 3 short axes in one bh	dto.
10	Irreversible injury	Late enhancement	3 short axes 3 long axes	Breath-held 3D long TI + short TI

Target heart rate: $(220 - \text{age}) \times 0.85$

ARVC (45 minutes) PRONE position if possible

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases T _{rot} = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine (one bh)
5	Planning of RV fct.	cine SSFP	3 long axis planes (apex -> pulm valve)	10 mm
6	RV function	cine SSFP	short axis (perpendicular to anatomical long axis)	6 mm covering entire RV
7	cross-sectional plane	cine SSFP	sagittal through suspicious areas	6 mm slice thickness 3 slices standard SSFP
8	Optional: RV fibrosis	Inversion-Recovery Gradient Echo	short axis (position from 6)	Avoid too short TI !
9	Optional: Visualization of fat	T1 turbo spin echo	short axis (position from 6)	with and without fat sat

Mitral valve regurgitation (30 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct. and aorta	real time	multiple axes	Realtime
3	LV function Routine patients	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	LV function Routine patients	cine short axis	3 short axis	base, mid LV, apex standard SSFP cine one bh
5	Stroke volume Aorta	Phase contrast	cross-sectional aorta	careful VENC selection: start with 150, then adjust
6	Valvular anatomy	cines SSFP	2-3 short axis at tips of valve at diastole	high resolution 5 mm small FoV consider GE cine LAX

Pulmonary veins pre/post ablation for AFib (20 minutes)

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	real time	multiple axes	Realtime
3	LV function	cine long axis	6 long axes	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	MRA pulmonary veins	MRA	coronal	0.15 mmol/kg Gadovist

Congenital studies - baseline imaging for all cases

	Item	Sequence	Orientation	Remarks
1	Localizer	Localizer	orthogonal, anatomical axes	
2	Planning of LV fct.	cine SSFP	multiple axes	Realtime
3	biventricular function	cine SSFP	3 long axes (2CV, 3CV, 4CV) short axis stack LV	slice thickness 8-10 mm bh 15 - 26 sec > 20 phases Tpat = 4
4	anatomical evaluation	static SSFP	true axial stack	10 mm slice thickness, no gap add coronal and / or sagittal stack if needed

Congenital - ASD (60 minutes)

	Item	Sequence	Orientation	Remarks
5	ASD visualization 1	SSFP	Atrial short axis stack	5 mm slices
6	ASD visualization 2	SSFP	2 long axes modified 4-ch. views	
7	ASD visualization 3	GRE FLASH cine with sat band	2 long axes modified 4-ch. views	with sat band left and right
8	Shunt quantification 1	Phase contrast	cross-sectional aorta	careful VENC selection
9	Shunt quantification 2	Phase contrast	cross-sectional pulm art	careful VENC selection
10	4-CV perfusion	Perfusion	3-4 true 4CVs	3 ml contrast, 20 saline bolus
11	MRA pulmonary veins	MRA	coronal	0.15 mmol/kg

Congenital - VSD (60 minutes)

	Item	Sequence	Orientation	Remarks
5	VSD visualization 1	SSFP	short axis stack	cover complete LV
6	VSD visualization 2	SSFP	2 long axes modified 4-ch. views	parallel to 4 CV
7	VSD visualization 3	SSFP	2 long axes modified 4-ch. views	with sat band left and right
8	Shunt quantification 1	Phase contrast	cross-sectional aorta	careful VENC selection
9	Shunt quantification 2	Phase contrast	cross-sectional pulm art	careful VENC selection
10	4-CV perfusion	Perfusion	3-4 true 4CVs	3 ml contrast, 20 saline bolus
11	MRA Aorta	MRA	parasagittal	0.15 mmol/kg angio not necessary, if other anatomy is normal

Congenital - Aortic coarctation (60 minutes)

	Item	Sequence	Orientation	Remarks
5	LV function	cine SSFP	6 long axes	short axis stack not needed in coarctation!
6	LVOT and aortic valve	SSFP	2 LVOT axes	short axis high res. aortic valve cine
7	Flow quantification 1	Phase contrast	cross-sectional ascending aorta	careful VENC selection
8	Flow quantification 2	Phase contrast	cross-sectional descending aorta	careful VENC selection
8a	Flow quantification 3 if collaterals are suspected	Phase contrast	aorta proximal to coarct. descending aorta @ level of diaphragm	
9	MRA Aorta	MRA	parasagittal	0.15 mmol/kg

Congenital - Tetralogy of Fallot TOF (90 minutes)

	Item	Sequence	Orientation	Remarks
5	Anatomy II	dark blood HASTE	axial and sagittal	
6	RV inflow tract	cine SSFP		
7	RV outflow tract	cine SSFP		
8	RVOT/pulm stenosis 1	cine SSFP	MPA and both PAs	
9	RVOT/pulm stenosis 2	Phase contrast	cross-sectional RVOT/pulm art	careful VENC selection
10	Pulm regurg	Phase contrast	cross-sectional pulm art	careful VENC selection for PR volume
11	MRA Pulm art	MRA	coronal	0.15 mmol/kg incl VIBE for aortic arch
12	Fibrosis assessment (selected cases)	late enhancement	short axis stack and sagittal LV	

Congenital - Fontan/single ventricle (90 minutes)

	Item	Sequence	Orientation	Remarks
5	Pulm art anatomy	SSFP	Long axis of both pulm art	
6	MRA Aorta	MRA	parasagittal	0.15 mmol/kg
7	Pulm vein anatomy	SSFP	2 coronal atrial views	
8	Flow quantification IVC	Phase contrast	cross-sectional IVC	careful VENC selection
9	Flow quantification SVC	Phase contrast	cross-sectional SVC	careful VENC selection
10	Flow quantification PV	Phase contrast	cross-sectional PV	careful VENC selection
11	Flow quantification Ao	Phase contrast	cross-sectional Ao	careful VENC selection
12	MRA			optional

Congenital - Coronary anomalies incl. Kawasaki's D.

(90 minutes)



	Item	Sequence	Orientation	Remarks
5	Ao valve planning 1	cine SSFP	LVOT long axis	
6	Ao valve planning 2	cine SSFP	LVOT long axis	
7	Aortic valve area	cine SSFP	cross-sectional valve	High-res, 6mm
8	Aortic arch	cine SSFP	parasagittal	
9	Coronary anatomy	3D SSFP	axial	T2 prep, navigator
10	Irreversible injuries	Late enhancement	short axis package	short and long TI

Congenital - Partial anomalous pulmonary veins

(60 minutes)

	Item	Sequence	Orientation	Remarks
5	Pulm vein anatomy 1	SSFP	2 axial atrial views	
6	Pulm vein anatomy 2	SSFP	2 sagittal atrial views	
7	Pulm vein anatomy 3	SSFP	2 oblique atrial views	with sat band
8	Pulm flow	Phase contrast	cross-sectional pulm art	careful VENC selection
9	Aortic flow	Phase contrast	cross-sectional ao	careful VENC selection
10	MRA pulmonary veins	MRA	coronal	0.15 mmol/kg