Supplemental Appendix

Supplemental Table 1. Transcatheter biopsies (n=9).

Age	Diagnosis	Location	Size, cm	Success?
3 months	Teratoma	Pericardium	4.7	N
1 year	Fibroma	LV wall	5.7	N
2.8 years	Epithelioid hemangioendothelioma	LA, RA, atrial septum	4	Y
3.1 years	Eosinophilic infiltrate, necrosis, granulation tissue	LV inflow, LV wall	3.1	Y
3.4 years	Fibroelastoma	RA	2.3	Y
4.5 years	Hemangioma	RV wall, septum, RV apex	4.9	Y
10 years	Necrotizing granulomatous infiltrate with fibrosis	RV apex, septum	2	Y
13 years	Angiosarcoma	RA, pericardium	6.2	Y
16 years	Alveolar rhabdomyosarcoma	RA, pericardium, IVC	4.9	Y

LV = left ventricle; RV = right ventricle; LA = left atrium; RA = right atrium; IVC = inferior vena cava; N=no; Y=yes. No complication was noted for transcatheter biopsies.

Supplemental Table 2. Malignant tumors (n=29).

Diagnosis	1° or 2° tumor	Age at dx	Treatment	Follow-up	Status at follow-up
Malignant germ cell tumor	Primary	44 days	Chemotherapy, surgical resection	4.5 years	Alive, asymptomatic
Anaplastic large cell lymphoma	Secondary	3 years	Chemotherapy	2 years	Mild LV dysfunction
Yolk sac tumor	Primary	3 years	Surgical resection	6 years	Alive, asymptomatic
Undifferentiated sarcoma	Primary	3 years	Surgical resection	<1 year	Deceased
Wilms tumor	Secondary	3 years	Surgical resection, chemotherapy	N/A	
Malignant rhabdoid tumor	Primary	5 years	Surgical resection, chemotherapy	5 years	Alive, asymptomatic
Pericardial monophasic synovial sarcoma	Secondary	6 years	Surgical resection, chemotherapy	4 years	Deceased
Wilms tumor	Secondary	7 years	Surgical resection, chemotherapy	N/A	
Synovial sarcoma	Primary	8 years	Surgical resection, chemotherapy	4 years	Alive, asymptomatic
Cardiac sarcoma	Primary	9 years	Chemotherapy, resection*	7 years	Alive, asymptomatic
Angiosarcoma	Primary	13 years	Surgical resection	< 1 year	Deceased
High grade leiomyosarcoma with myxoid features	Primary	13.2 years	Surgical resection/debulking	N/A	
Alveolar rhabdomyosarcoma	Secondary	14 years	Chemotherapy, radiation	4 years	Deceased
Synovial sarcoma	Secondary	14 years	Chemotherapy, heart transplant	1 year	Alive, asymptomatic
Low to intermediate grade sarcoma	Primary	14 years	Surgical resection	< 1 year	No recurrence
Epithelioid angiosarcoma	Primary	14 years	Surgical resection, chemotherapy	N/A	
B cell lymphoma	Secondary	15 years	Chemotherapy	< 1 year	Alive, asymptomatic
Rhabdomyosarcoma	Secondary	16 years	Chemotherapy, pericardial drain	< 1 year	Deceased
Immature teratoma, malignant non-germ cell component	Primary	16 years	Surgical resection, chemotherapy	1 year	Deceased
Unclassified pleomorphic epithelioid malignant neoplasm	Primary	16 years	Chemotherapy, radiation	N/A	
Midline NUT carcinoma	Secondary	16.8 years	Chemotherapy	< 1 year	Deceased
Acute myeloblastic leukemia	Secondary	17 years	Chemotherapy	< 1 year	Deceased
Angiosarcoma	Primary	17 years	Chemotherapy, radiation	2 years	Deceased
Angiosarcoma	Primary	17 years	Chemotherapy, resection	1 year	Residual problems
Burkitt lymphoma	Secondary	17 years	Chemotherapy	N/A	
Alveolar soft part sarcoma	Secondary	17.3 years	Chemotherapy	N/A	
Undifferentiated sarcoma	Secondary	17.9 years	Chemotherapy, radiation	< 1 year	Pain, side effects from chemo
Rhabdomyosarcoma	Secondary	18 years	Pericardial window	<1 year	Deceased
Angiosarcoma	Primary	18 years	Surgical resection, chemotherapy	2 years	Deceased

*Initially the mass was deemed unresectable, but became resectable following chemotherapy.

Supplemental Table 3. Univariate predictors of death by Cox regression (n=164).

Variable	HR	95% CI	p value
Age at CMR			
Low (<0.7 years)	Ref		0.160
Medium (0.7-7.3 years)	0.35	0.08, 1.63	
High (>7.3 years)	0.22	0.05, 1.06	
Male	0.73	0.28, 1.89	0.514
Prenatal diagnosis	7.50	1.84, 30.60	**0.005**
History of malignancy	2.67	1.00, 7.14	0.050
Respiratory symptoms	1.82	0.57, 5.82	0.310
Arrhythmia	0.28	0.05, 1.54	0.142
Murmur	0.26	0.01, 4.61	0.356
Chest pain	1.87	0.65, 5.39	0.250
Fever	5.34	1.47, 19.40	**0.011**
Neurologic symptoms	1.13	0.20, 6.47	0.891
Pericardial effusion	5.22	2.05, 13.32	**<0.001**
Pleural effusion	3.40	1.28, 9.05	**0.014**
Hemodynamic impact	8.01	2.83, 22.69	**<0.001**
Multiple	1.59	0.56, 4.50	0.386
Well circumscribed	0.35	0.13, 0.94	**0.037**
Infiltrative	3.51	1.34, 9.18	**0.011**
Intramyocardial	0.32	0.09, 1.05	0.060
Intrapericardial	3.74	1.41, 9.94	**0.008**
Epicardial	1.29	0.43, 3.86	0.652
Anterior mediastinal	2.05	0.51, 8.17	0.311
Posterior mediastinal	1.31	0.23, 7.50	0.759
Endocardial	0.70	0.21, 2.32	0.560
SVC/IVC location	4.25	1.39, 13.03	**0.011**
Atrium location	1.43	0.55, 3.74	0.469
Inflow location	1.38	0.23, 8.14	0.722
Outflow location	0.54	0.03, 10.01	0.679
LV location	0.56	0.19, 1.68	0.304
Septum location	0.36	0.07, 2.02	0.247
RV location	1.73	0.57, 5.29	0.333
Mass:cardiac length ratio			0.127
Small (<0.34)	Ref		
Medium (0.34-0.57)	1.47	0.42, 5.23	
Large (>0.57)	3.23	0.97, 10.73	
Cine SSFP tertile			0.971
Low (<1.1)	Ref		
Medium (1.1-1.6)	0.96	0.27, 3.43	
High (>1.6)	0.88	0.30, 2.58	
Pre-gadolinium T1 intensity ratio			0.395
Low (<1)	Ref		
Medium (1-1.2)	1.03	0.31, 3.37	
High (>1.2)	0.50	0.15, 1.67	
Fat content	0.92	0.04, 19.20	0.959
T2 intensity ratio			0.452
Low (<1.1)	Ref		
Medium (1.1-1.7)	2.46	0.53, 11.37	
High (>1.7)	2.47	0.56, 10.86	
FPP intensity ratio ≥ 1	1.35	0.32, 5.60	0.683
LGE intensity ratio			0.663
Low (<1.4)	Ref		
Medium (1.4-4.2)	0.84	0.23, 3.10	
High (>4.2)	0.51	0.12, 2.27	

CMR = cardiovascular magnetic resonance, SVC = superior vena cava, IVC = inferior vena cava, LV = left ventricle, RV = right ventricle, SSFP = steady state free precession, FPP = first pass perfusion, LGE = late gadolinium enhancement.

Supplemental Table 4. Technical characteristics of 213 CMR examinations.

Variable	N (%)
Scanner	
GE	42 (20)
Philips	81 (38)
Siemens	90 (42)
Field strength	
1.5T	207 (97)
3T	6 (3)
Sedation	
No sedation	70 (33)
General anesthesia	123 (58)
IV sedation	10 (5)
Anxiolysis	2 (1)
Unknown	8 (4)
Image quality	
Very good	108 (51)
Good	84 (39)
Fair	20 (9)
Poor	1 (<1)
Sequences	
Cine SSFP	211 (99)
T1 TSE	179 (84)
T2 TSE	170 (80)
Fat content imaging	165 (77)
First pass perfusion	150 (70)
LGE	166 (78)

GE = General Electric; IV = intravenous; SSFP = steady state free precession; TSE = turbo spin echo; LGE = late gadolinium enhancement.

Supplemental Table 5. Patient and mass characteristics. Median (IQR) and frequency (%).

Mass type	All (N=213)*	Fibroma (N=73)	Rhabdomyoma (N=32)	Malignant (N = 29)	Myxoma (N=15)	Teratoma (N=9)	Hemangioma (N=6)
Age at CMR (years)	3 (0.4, 12)	0.7 (0.3, 5.4)	0.3 (0, 1.5)	14 (8, 17)	13 (8, 15)	0.04 (0, 0.2)	9.5 (4.5, 14)
Prenatal diagnosis	38 (18)	15 (38)	18 (56)	0	0	4 (44)	1 (17)
Male sex	110 (52)	37 (51)	14 (44)	14 (48)	5 (33)	4 (44)	5 (83)
Genetic diagnosis	51 (24)	11 (15)	27 (84)	0	4 (27)	0	0
History of malignancy	16 (8)	1 (1)	0	13 (43)	1 (7)	0	0
Presenting symptoms†							
Respiratory	41 (19)	15 (21)	3 (9)	8 (28)	1 (7)	5 (56)	0
Arrhythmia	41 (19)	26 (36)	5 (16)	2 (7)	1 (7)	0	0
Murmur	31 (15)	15 (21)	3 (9)	1 (3)	3 (20)	0	1 (17)
Chest pain	17 (8)	3 (4)	0	8 (28)	1 (7)	0	0
Fever	13 (6)	0	0	4 (14)	1 (7)	0	0
Neurologic	13 (6)	2 (3)	3 (9)	2 (7)	2 (13)	0	0
Fatigue	8 (4)	1 (1)	0	3 (10)	0	0	2 (33)
Gross characteristics							
Largest dimension (cm)	4 (2.2, 5.3)	5 (3.5, 5.8)	2.6 (1.9, 3.6)	5 (4.1, 7)	1.6 (0.9, 4.1)	4.7 (4.1, 5)	1.8 (1.6, 2,4)
Mass-to-cardiac length ratio	0.44 (0.3, 0.6)	0.6 (0.4, 0.8)	0.4 (0.3, 0.5)	0.5 (0.3, 0.6)	0.1 (0.1, 0.3)	1 (0.8, 1)	0.1 (0.1, 0.3)
Multiple masses	29 (14)	4 (5)	9 (28)	9 (31)	1 (7)	0 (0)	0 (0)
Well-circumscribed	178 (84)	73 (100)	31 (97)	11 (38)	10 (67)	9 (100)	5 (83)
Infiltrative appearance	37 (17)	0	1 (3)	21 (72)	0	1 (11)	1 (17)
Pericardial effusion	52 (24)	23 (32)	4 (13)	9 (31)	1 (7)	7 (78)	0 (0)
Pleural effusion	19 (9)	2 (3)	0 (0)	10 (34)	0 (0)	3 (33)	0 (0)
Hemodynamic impact	79 (37)	23 (31)	12 (38)	13 (45)	4 (27)	9 (100)	1 (17)
Location							
SVC/IVC	11 (5)	0	0	5 (17)	0	0	1 (17)
RA/LA/Atrial septum	56 (26)	4 (5)	6 (19)	17 (59)	7 (47)	2 (22)	2 (33)
Inflow/MV/TV	19 (9)	1 (1)	3 (9)	4 (14)	2 (13)	0	2 (33)
Outflow/AoV	18 (8)	2 (3)	6 (19)	1 (3)	1 (7)	0	1 (17)
Left ventricle	78 (36)	44 (60)	14 (44)	5 (17)	3 (20)	0	0
Septum/Crux	44 (21)	24 (33)	9 (28)	2 (7)	1 (7)	1 (11)	1 (17)
Right ventricle	44 (21)	14 (19)	10 (31)	8 (28)	0	1 (11)	3 (50)
Intramyocardial	108 (51)	70 (96)	20 (63)	5 (17)	0	1 (11)	1 (17)
Epicardial	27 (13)	1 (1)	8 (25)	10 (34)	0	1 (11)	0
Endocardial	51 (24)	3 (4)	7 (22)	5 (17)	15 (100)	0	4 (67)
Intrapericardial	22 (10)	0	1 (3)	9 (31)	0	8 (89)	0
Anterior mediastinal	8 (4)	0	0	7 (24)	0	0	0
Posterior mediastinal	7 (3)	0	0	3 (10)	0	0	0
Tissue characteristics							
Cine intensity ratio	1.3 (1, 1.9)	1.1 (0.9, 1.3)	1.2 (1, 1.4)	1.6 (1.2, 2)	2.3 (2, 2.8)	2.8 (2.6, 3.3)	2 (1.6, 2.2)
Pre-Gd T1 imaging intensity ratio	1.1 (0.9, 1.3)	1 (0.9, 1.1)	1.1 (0.9, 1.2)	1.2 (1, 1.4)	1.2 (0.9, 1.3)	1 (0.6, 1)	1.1 (1, 1.3)
T2 imaging intensity ratio	1.5 (1, 2)	1.3 (0.9, 1.5)	1.2 (1.1, 1.7)	1.9 (1.5, 2.4)	1.9 (1.4, 2.5)	2.1 (1.3, 3.1)	2.6 (2.3, 3.3)
Evidence of fat content	9/165 (5)	0/59 (0)	1/22 (5)	1/22 (5)	0/10 (0)	0/7 (0)	0/6 (0)
First pass perfusion intensity ratio	0.4 (0.3, 0.6)	0.4 (0.3, 0.5)	0.6 (0.5, 0.7)	0.5 (0.4, 0.6)	0.4 (0.3, 0.6)	0.3 (0.2, 0.3)	1.8 (1.6, 2)
LGE intensity ratio	2.8 (1.1, 6.5)	4.5 (2.8, 12.2)	1 (0.4, 1.1)	2 (1.1, 4.9)	1.4 (1, 5.3)	1 (0.7, 1.9)	8.4 (3.9, 11.3)
Fibroma LGE pattern	66/166 (40)	52/60 (87)	0/21 (0)	5/23 (22)	2/13 (15)	0/4 (0)	0/6 (0)

Mass type	Fatty Deposits in TSC (N=7)	Angiosarcoma‡ (N=5)	Thrombus (N=5)	Infectious/ Inflammatory (N=5)	Papillary fibroelastoma (N=3)	Benign myofibroblastic mass (N=5)	IMT (N=4)
Age at CMR (years)	12 (7, 15)	17 (14, 17)	1.5 (0.9, 3.7)	3.1 (1.5, 10)	11 (3.1, 14)	3.4 (0.8, 3.5)	14 (7, 15)
Prenatal diagnosis	0	0	0	0	0	0	0
Male sex	6 (86)	1 (20)	4 (80)	3	2 (67)	3 (60)	3 (75)
Genetic diagnosis	7 (100)	0	0	0	0	0	0
History of malignancy	0	1 (20)	0	0	0	1 (20)	0
Presenting symptoms†							
Respiratory	0	0	2 (40)	0	0	0	1 (25)
Arrhythmia	1 (14)	0	1 (20)	1 (20)	0	0	1 (25)
Murmur	0	0	2 (40)	0	1 (33)	1 (20)	2 (50)
Chest pain	1 (14)	3 (60)	1 (20)	0	0	0	0
Fever	0	0	1 (20)	1 (20)	1 (33)	0	1 (25)
Neurologic	1 (14)	1 (20)	0	0	0	0	1 (25)
Fatigue	0	1 (20)	0	0	0	0	1 (25)
Gross characteristics							
Largest dimension (cm)	0.8 (0.5, 4.1)	6.2 (6.2, 8.9)	1.9 (1.1, 2.2)	2 (1.4, 3.1)	1 (0.6, 1.3)	1.9 (1.3, 2.3)	3.9 (0.3, 6.6)
Mass-to-cardiac length ratio	0.1 (0.04, 0.3)	0.5 (0.5, 0.6)	0.2 (0.1, 0.3)	0.2 (0.2, 0.4)	0.1 (0.1, 0.1)	0.3 (0.2, 0.3)	0.3 (<0.1, 0.5)
Multiple masses	3 (43)	2 (40)	1 (20)	0	0	0	0
Well-circumscribed	6 (86)	2 (40)	5 (100)	3 (60)	3 (100)	5 (100)	2 (50)
Infiltrative	0	5 (100)	0	2 (40)	0	2 (40)	2 (50)
Pericardial effusion	0 (0)	2 (40)	0 (0)	1 (20)	0	2 (40)	0
Pleural effusion	0 (0)	3 (60)	1 (20)	1 (20)	0	0	0
Hemodynamic impact	0 (0)	4 (80)	1 (20)	1 (20)	1 (33)	3 (60)	3 (75)
Location							
SVC/IVC	0	1 (20)	2 (40)	1	0	0	0
RA/LA/Atrial septum	1 (14)	5 (100)	3 (60)	1	0	2 (40)	1 (25)
Inflow/MV/TV	0	0	0	2	2 (67)	1 (20)	2 (50)
Outflow/AoV	0	0	0	0	1 (33)	3 (60)	1 (25)
Left ventricle	5 (71)	0	0	2	0	1 (20)	1 (25)
Septum/Crux	4 (57)	0	0	1	0	0	0
Right ventricle	1 (14)	1 (20)	0	1	0	0	1 (25)
Intramyocardial	4 (57)	0	0	1 (20)	0	1 (20)	1 (25)
Epicardial	4 (57)	0	0	0	0	0	0
Endocardial	0	1 (20)	5 (100)	2 (40)	3 (100)	2 (40)	3 (75)
Intrapericardial	0	1 (20)	0	0	0	0	0
Anterior mediastinal	0	1 (20)	0	0	0	0	0
Posterior mediastinal	0	0	0	0	0	0	0
Tissue characteristics							
Cine intensity ratio	0.9 (0.7, 3.5)	1.7 (1.6, 2.1)	1.1 (1, 2.1)	1.5 (1.1, 1.9)	1.3 (1.2, 3.6)	1.6 (1, 1.6)	1.5 (1.2, 3)
Pre-Gd T1 imaging intensity ratio	1.9 (1.6, 2.3)	1.4 (1.1, 3)	1 (0.9, 1.1)	0.8 (0.7, 1)	1 (0.9, 1)	1.2 (1, 1.2)	1.6 (0.9, 1.7)
T2 imaging intensity ratio	0.7 (0.7, 1.6)	2.1 (1.7, 2.3)	1 (0.8, 1.3)	1.4 (1.3, 2)	1 (0.9, 3.1)	1.9 (1.7, 2)	1.4 (0.7, 1.9)
Evidence of fat content	7/7 (100)	0/4 (0)	0/3 (0)	0/3 (0)	0/2 (0)	0/2 (0)	0/3 (0)
First pass perfusion intensity ratio	0.8 (0.3, 0.9)	1 (0.7, 1.2)	0.3 (0.2, 0.8)	0.5 (0.4, 0.5)	0.7 (0.4, 1.3)	0.3 (0.3, 0.4)	0.5 (0.3, 0.6)
LGE intensity ratio	3 (2.2, 4.8)	2.6 (2.4, 3.1)	1.1 (0.3, 1.3)	4.8 (1.5, 8.7)	1.5 (1.3, 1.8)	0.6 (0.5, 2.4)	2.4 (1, 14)
Fibroma LGE pattern	0/4 (0)	2/5 (40)	0/3 (0)	1/3 (33)	1/2 (50)	2/5 (40)	1/3 (33)

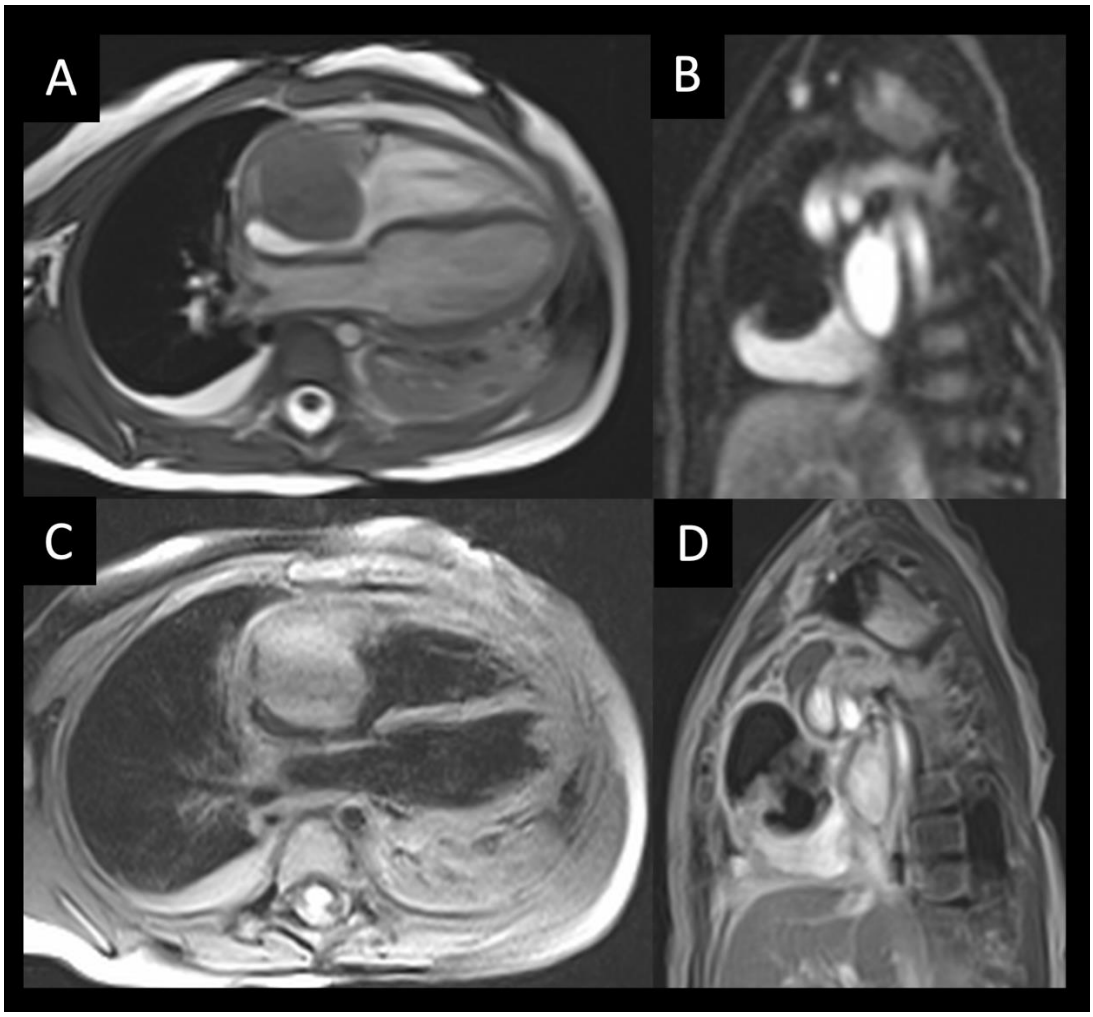
Mass type	Cyst§ (N=4)	Rosai Dorfman disease (N=3)	Hemangioendothelioma (N=3)	Neurofibroma (N=2)	Paraganglioma (N=2)	Lymphatic malformation (N=2)	Other vascular malformation (N = 2)‖
Age at CMR (years)	2.8 (1.9, 6)	12 (3, 13.4)	2.8 (0.4, 16)	9.6 (3.3, 16)	17.3 (16.5, 18)	9.4 (6.8, 12)	5.2 (3.7, 6.7)
Prenatal diagnosis	0	0	0	0	0	0	0
Male sex	3 (75)	1 (33)	2 (67)	1 (50)	1 (50)	0 (0)	2 (100)
Genetic diagnosis	0	0	0	2	0	0	0
History of malignancy	0	0	0	0	0	0	0
Presenting symptoms†							
Respiratory	2 (50)	0	1 (33)	1 (50)	0	1 (50)	1 (50)
Arrhythmia	1 (25)	0	0	0	2 (100)	0	0
Murmur	1 (25)	1 (33)	0	0	0	0	0
Chest pain	0	2 (67)	0	0	0	1 (50)	0
Fever	1 (25)	0	1 (33)	0	0	1 (50)	1 (50)
Neurologic	0	1 (33)	0	0	0	0	0
Fatigue	0	0	1 (33)	0	0	0	0
Gross characteristics							
Largest dimension (cm)	3.9 (2.3, 4.9)	2.9 (2.8, 5.1)	4 (3.7, 6.1)	6.5 (4.9, 8)	3.5 (3.4, 3.6)	6 (4.9, 7)	5.9 (5.5, 6.3)
Mass-to-cardiac length ratio	0.5 (0.4, 0.5)	0.3 (0.3, 0.4)	0.4 (0.4, 0.6)	0.6 (0.6, 0.7)	0.2 (0.2, 0.3)	0.5 (0.5, 0.5)	0.6 (0.5, 0.6)
Multiple masses	0	1 (33)	0	2 (100)	0	0	0
Well-circumscribed	4 (100)	2 (67)	3 (100)	0	2 (100)	1 (50)	1 (50)
Infiltrative	0	1 (33)	3 (100)	1 (50)	0	1 (50)	0
Pericardial effusion	1 (25)	1 (33)	0	1 (50)	0	1 (50)	0
Pleural effusion	1 (25)	0	0	0	0	1 (50)	0
Hemodynamic impact	2 (50)	1 (33)	2 (67)	0	0	1 (50)	0
Location							
SVC/IVC	1 (25)	0	0	0	0	0	0
RA/LA/Atrial septum	1 (25)	2 (67)	3 (100)	2 (100)	1 (50)	1 (50)	0
Inflow/MV/TV	0	0	0	0	0	0	0
Outflow/AoV	2 (50)	1 (33)	0	0	0	0	0
Left ventricle	0	0	1 (33)	0	0	0	1 (50)
Septum/Crux	0	1 (33)	0	0	0	0	1 (50)
Right ventricle	0	0	0	0	0	2 (100)	0
Intramyocardial	0	1 (33)	0	1 (50)	0	0	1 (50)
Epicardial	0	1 (33)	0	1 (50)	0	2 (100)	0
Endocardial	0	1 (33)	0	0	0	0	0
Intrapericardial	2 (50)	0	0	0	1 (50)	1 (50)	0
Anterior mediastinal	0	0	0	0	0	0	1 (50)
Posterior mediastinal	1 (25)	0	0	2 (100)	0	0	0
Tissue characteristics							
Cine intensity ratio	3.3 (2.7, 3.8)	1 (0.7, 1.9)	1.4 (1.1, 1.7)	1.2 (0.9, 1.6)	2.3 (2.1, 2.5)	3 (2, 4)	3.4 (3, 3.8)
Pre-Gd T1 imaging intensity ratio	0.9 (0.8, 1.7)	0.9 (0.8, 1.5)	1.3 (0.9, 1.4)	-	1.1	1.7 (1.6, 1.7)	2.1
T2 imaging intensity ratio	2.2 (2, 3.4)	0.9 (0.7, 1.1)	2.1 (1.7, 3.3)	2.1	2.2 (2.1, 2.3)	3.6 (1.3, 5.9)	3.4
Evidence of fat content	0/3 (0)	0/2 (0)	0/3 (0)	0/1 (0)	0/2 (0)	0/2 (0)	0/2 (0)
First pass perfusion intensity ratio	0.4 (0.4, 0.4)	0.7 (0.5, 0.9)	1.3	0.4	2.6 (2.6, 3.2)	0.3 (0.3, 0.3)	0.6
LGE intensity ratio	0.9 (0.4, 1.4)	7.7 (1.6, 14)	2.7 (1.3, 14)	0.2	5.3 (4.8, 5.8)	1.7 (0.4, 3.1)	4.2 (1.1, 7.3)
Fibroma LGE pattern	0/2 (0)	0/2 (0)	1 (33)	0/1 (0)	1/2 (50)	0/2 (0)	0/2 (0)

CMR = cardiovascular magnetic resonance; SVC = superior vena cava; IVC = inferior vena cava; RA = right atrium; LA = left atrium; MV = mitral valve; TV = tricuspid valve; AoV = aortic valve; LGE = late gadolinium enhancement; TSC = tuberous sclerosis complex. Mass types listed in red were not represented in the previously published diagnostic criteria. *Two masses not listed: lipomatous hypertrophy of the atrial wall and glomus tumor. †Respiratory symptoms: respiratory distress, cough, tachypnea, abnormal chest radiograph, cyanosis. Neurologic symptoms: seizure, stroke, syncope, presyncope. ‡Angiosarcoma also included in malignant tumors. §Includes bronchogenic cyst (n=2), foregut duplication cyst (n=1), and pericardial cyst (n=1). ‖Benign vascular lesion, favor vascular malformation, predominantly venous-capillary type; and vascular (venous and lymphatic) malformation involving thymic lobe.

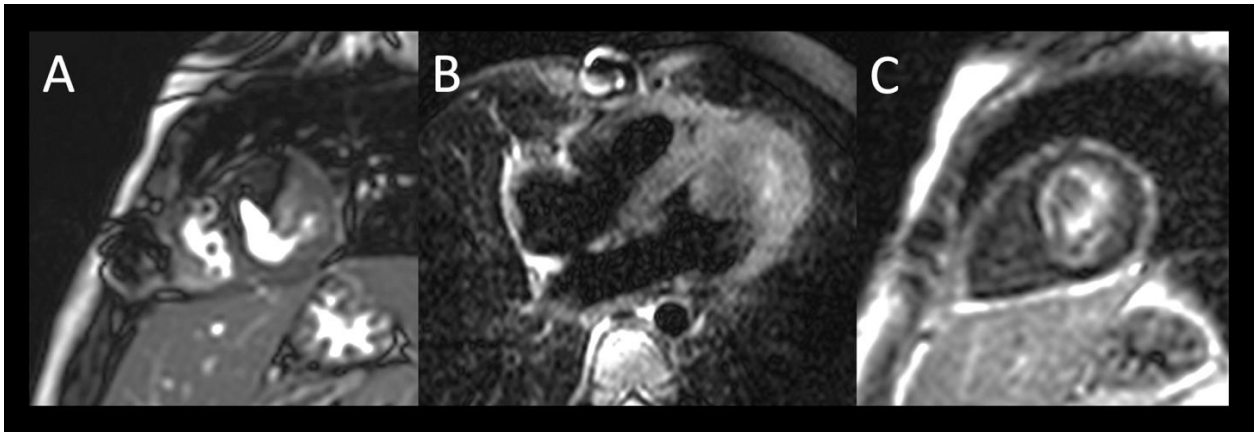
Supplemental Table 6. Univariate logistic regression by mass type.

Variable	Fibroma	Rhabdomyoma	Malignant	Myxoma	Teratoma	Fatty deposits in TSC	Hemangioma	Thrombus	Angiosarcoma*
N	**73**	**33**	**30**	**15**	**9**	**6**	**6**	**5**	**5**
Age at CMR	↓	↓	↑	↑	↓				↑
Prenatal diagnosis		+	-		-				
History of malignancy	-		+						
Presenting symptoms									
Respiratory symptoms					+				
Neuro symptoms									
Arrhythmia	+								
Fever									
Heart murmur									
Chest pain			+						+
Fatigue							+		+
Gross characteristics									
Absolute dimension	↑		↑	↓					↑
Mass-to-length ratio	↑			↓	↑				
Multiple	-	+	+			+			
Well-circumscribed	+		-						-
Infiltrative	-		+						+
Pericardial effusion					+				
Pleural effusion	-		+		+				+
Hemodynamic impact					+				
Location									
SVC/IVC			+					+	
RA/LA/Atrial septum	-		+						+
Inflow/MV/TV	-						+		
Outflow/AoV		+							
LV	+		-						
Septum/Crux	+					+			
RV									
Intramyocardial	+		-	-	-				
Epicardial	-	+	+			+			+
Endocardial	-			+			+	+	
Intrapericardial	-		+		+				
Anterior mediastinal			+						+
Posterior mediastinal			+						
Tissue characteristics									
Cine intensity ratio	↓	↓		↑	↑				
Pre-Gd T1 intensity ratio	↓								
T2 intensity ratio	↓		↑				↑		
Fat content						+			
FPP intensity ratio	↓						↑		↑
LGE intensity ratio	↑	↓							
Fibroma LGE pattern	+	-							

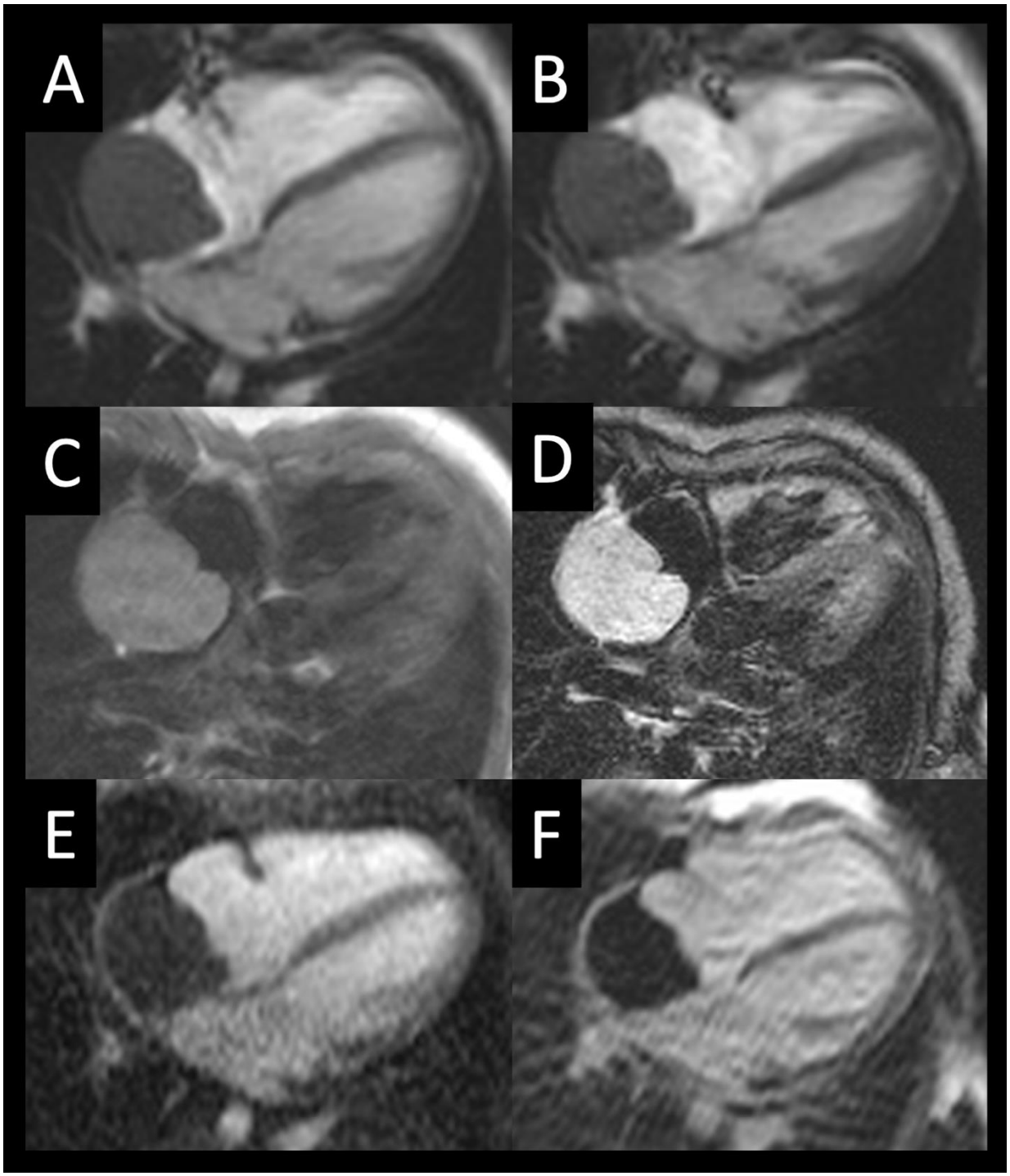
↓ indicates a low value, - indicates a negative association, ↑ indicates a high value, and + indicates a positive association.
↓, ↑, +, or - indicates $p < 0.05$.
↓, ↑, +, or - indicates $p < 0.01$.
TSC = tuberous sclerosis complex. *Angiosarcoma is also included in the category 'Malignant'.



Supplemental Figure 1. Right atrial fibroma, with incorrect selection of ‘malignant’ as a differential diagnosis by Reviewer 1. This 18 month old girl presented with fatigue, pericardial effusion, abnormal chest radiograph, and respiratory symptoms. A large mass is seen in the right atrium by cine SSFP imaging (A). On first pass perfusion imaging, the mass does not enhance (B). The mass is isointense on T1 weighted imaging (C), and the mass has patchy regions of enhancement on LGE imaging (D). A right pleural effusion is also seen on axial images (A, C). The location and LGE appearance are atypical for fibroma.



Supplemental Figure 2. Left ventricular rhabdomyoma, with incorrect selection of ‘malignant’ as a differential diagnosis by Reviewer 2. Metallic susceptibility artifact obscures a portion of the mass on cine SSFP imaging (A). The mass is intracavitary with low signal intensity on T1 weighted imaging with fat suppression (B), and the mass has rim enhancement on LGE imaging, that is atypical for rhabdomyoma (C).



Supplemental Figure 3. Right atrial rhabdomyoma, with incorrect selection of ‘malignant’ as a differential diagnosis by Reviewer 2. This 2.5 year old girl initially presented with supraventricular tachycardia. The mass appeared to protrude from the right atrium into the pericardial space on cine SSFP imaging in diastole (A) and systole (B). The mass was hyperintense on T1 weighted imaging (C) and T2 weighted imaging with fat suppression (D). The mass did not enhance on first pass perfusion imaging (E) or LGE imaging (F). Although the mass has some atypical features (large size beyond infancy, and solitary mass), the tissue characteristics are consistent with rhabdomyoma.

Table 3. CMR-based diagnostic criteria of cardiac masses in children.

	Fibroma	**Rhabdomyoma**	**Malignant**	**Myxoma**	**Teratoma**	**Fatty deposits in TSC§**	**Thrombus**	**Infectious/ inflammatory**	**IMT**	**Rosai Dorfman**	**Papillary fibroelastoma**	**Benign myofibroblastic mass**	**Neuro-fibroma**	**Lipoma**	**Cyst**	**Paraganglioma**	**Hemangioma**	**Angiosarcoma**	**Hemangio-endothelioma**	**Vascular malformation**	**Glomus tumor**
Classification	Fibroblastic	Muscular	Various	Endocardial	Ectopic tissue	Lipomatous	Other	Infectious/ inflammatory	Endocardial	Histiocytic	Endocardial	Fibroblastic	Peripheral nerve sheath	Lipomatous	Malformation/ ectopic tissue	Neuroendocrine	Vascular anomaly	Vascular anomaly	Vascular anomaly	Vascular anomaly	Vascular anomaly
Size	2-10 cm	<1-8 cm	1-10 cm	<1-9 cm*	3-7 cm	<1-5 cm	1-2 cm	1-3 cm	<1-6 cm	3-5 cm	<1-2 cm	1-2 cm	5-8 cm	1-5 cm	1-5 cm	3-4 cm	1-5 cm	6-9 cm	3-6 cm	5-10 cm	<1-10 cm
Location & appearance	•Intra-myocardial •Well circumscribed •Solitary ± lobules •Septum, free wall, or both •LV >> RV (can be atrium)	•Intracavitary •Attached to LV or RV muscle •Can be atrium or epicardial •Usually multiple†	•Commonly SVC/IVC/RA •Epicardial, intrapericardial, anterior/posterior mediastinal •Infiltrative‡ •May cross tissue plane	•Typically left atrium but can be any chamber* •Endocardial, pedunculated, mobile, heterogeneous •Mimics other masses: variable locations & appearance	•Usually intrapericardial, compresses SVC/RA •Multilocular, bosselated, solid & cystic areas • May be intramyocardial or intracavitary	•Intra-myocardial •Commonly ventricular septum •Epicardial •Often multiple	•Intracavitary •SVC/IVC •Endocardial •Often in regions of stasis (lines, infarcts)	•Variable locations •Endocardial or intra-myocardial	•Usually endocardial & intracavitary •Can be intramyocardial or intrapericardial •RA/RV more common •Often polypoid, broad-based	•Variable	•Endocardial •Valve (usually mitral or aortic) •Pedunculated •Mobile	•Outflow tract •Well circumscribed	•Posterior mediastinal •Multiple	•Any location •Commonly intramyocardial or endocardial •May be valvular, pedunculated, mobile	•Pericardium •Posterior mediastinum (bronchogenic or foregut duplication cyst)	•Intrapericardial, sympathetic chain •Blood supply from coronary circulation •Multiple vascular channels •Encapsulated, well-circumscribed	•Any location, commonly RA during infancy •Commonly inflow tracts •Commonly endocardial •Vascular channels	•Right atrium •Infiltrative •Extends to epicardium and anterior mediastinum •Rapid growth	•Right atrium •Left atrium •Occasionally ventricle •May be infiltrative with pericardial or mediastinal extension	•Solitary •Well circumscribed •Intramyocardial or epicardial •Heterogenous •Lymphatic malformation is commonly in RA, encasing a coronary artery	•Solitary or multiple intramyocardial masses
Cine SSFP	--	--	±	++	+	± (Rim of chemical shift artifact)	±	+	+	±	+	+	±	--	+	+	+	+	±	+	+
T1	--	--	±	±	--	+	--	--	±	±	--	--	+	+	±	--	±	+	±	+	+
T2	± (Heterogeneous)	±	+	+	+	-- (T2/FS)	--	+	±	±	±	+	+	-- (T2/FS)	++	+	+	+	+	+	+
Fat suppression	No	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	--
FPP	--	--	±	--	--	--	--	--	--	--	±	--	--	--	--	+++	++	++	±	±	++
LGE	+++ (Fibroma LGE pattern)	--	±	±	±	--	±	++	± (sometimes ++)	++	+	±	--	--	--	++ (Peripheral enhancement)	++	+	±	±	++
Pericardial effusion	Common	Uncommon	Common	Uncommon	Common	No	Uncommon	Common	Uncommon Infants	Common	Uncommon	Uncommon	Uncommon	Uncommon	Common	Uncommon	Infants	Common	Infants	Common	Common
Other	•Usually dx prenatally or in infancy •Ventricular arrhythmia •Microscopic calcifications & regions of necrosis •Gorlin syndrome (15% CMR cases)	•Usually dx prenatally or infancy •Tuberous sclerosis (>80% cases) •Atrial and ventricular arrhythmias	•Pleural effusion •Usually older children •History of malignancy •Chest pain •Multiple •High mortality •Metabolic activity on ^{18}F-FDG-PET	•Usually older children •↑prevalence in females •Triad of symptoms: (obstructive, constitutional, systemic emboli) •Carney complex (30% CMR cases)	•Usually dx prenatally or infancy •Pericardial/pleural effusion •Respiratory symptoms	•Older children with tuberous sclerosis	•Dark on T1 scout imaging •Dark on LGE sequence, long inversion time	•Fever •Anemia •Thrombo-cytopenia •Chest pain •Inflammatory pseudotumor •Metabolic activity on ^{18}F-FDG-PET	•ALK gene expression •May be locally aggressive with recurrence and metastasis •Heart murmur, fatigue •Metabolic activity on ^{18}F-FDG-PET	•Neuro symptoms •Chest pain •Metabolic activity on ^{18}F-FDG-PET	•Murmur •Embolic events	•Hemodynamic impact	•Older children •Neuro-fibromatosis •At risk for malignant degeneration	•Range of clinical presentations, usually benign but may cause syncope or sudden death depending on location and risk of embolization	•Pericardial cysts may increase in size on repeat imaging	•Catecholamine excess: arrhythmia, hypertension •Teenagers/young adults •Succinate dehydrogenase subunit B mutation associated with malignant disease	•Often incidental diagnosis •Fatigue •Fetal or neonatal presentation: pericardial effusion and tamponade	•Malignant •Metastatic •Older children •Chest pain •Fatigue •Dyspnea •Pleural effusion •High mortality •Metabolic activity on ^{18}F-FDG-PET	•Range of behavior with malignant potential including metastasis (epithelioid subtype) •Fetal or neonatal presentation: pericardial effusion •Kasabach Merritt phenomenon (consumptive coagulopathy) in Kaposiform subtype •Metabolic activity on ^{18}F-FDG-PET (described in non-cardiac locations)	•May have arterial, capillary, venous and/or lymphatic components •Resection may not be possible or may risk injury to cardiac structures •Often respiratory symptoms, sometimes asymptomatic	•Resection may not be possible or may risk injury to cardiac structures •Usually found in the subungual regions of fingers and distal extremities (rare cardiac involvement). •Usually benign, may be metastatic or have malignant potential
Differential diagnosis	•Myofibroma	•Thrombus	•Various	•Fibroelastoma •Malignant	•Hemangioma •Pericardial cyst	•Lipoma	•Rhabdomyoma	•Endocarditis •IMT •Papillary fibroelastoma	•Low grade sarcoma •Myxoma •Papillary fibroelastoma •Inflammatory pseudotumor	•Infectious/ inflammatory	•Infectious/ inflammatory •Myxoma	•Papillary fibroelastoma	•Malignant	•Lipomatous hypertrophy of the atrial septum •Fatty deposits in TSC	•Hydatid cyst •Teratoma •Lymphatic malformation	•Vascular anomalies	•Teratoma (infants) •Angio-sarcoma •Hemangio-endothelioma •Paraganglioma	•Hemangio-endothelioma •Other malignancy	•Myxoma •Hemangioma •Angiosarcoma	•Pericardial cyst •Teratoma	•Hemangioma •Hemangio-endothelioma

-- = iso or hypointense, ± = variable intensity, + = hyperintense, ++ = strongly hyperintense. LV = left ventricle, RV = right ventricle, SVC = superior vena cava, RA = right atrium, SSFP = steady state free precession, FPP = first pass perfusion, LGE = late gadolinium enhancement, TSC = tuberous sclerosis complex, IMT = inflammatory myofibroblastic tumor, T2/FS = T2-weighted imaging with fat suppression, ^{18}F-FDG-PET = ^{18}F-fluorodeoxyglucose positron emission tomography. *Myxomas referred for CMR are typically smaller than average and less likely to be located in the left atrium (referral bias). †Rhabdomyomas referred for CMR are commonly solitary (referral bias). ‡Infiltrative: (1) Poorly defined edges, (2) infiltrating myocardium or crossing a tissue plane within the heart, (3) involving both cardiac and extracardiac structures, or (4) appearance of linear growth through a large vessel such as the superior or inferior vena cava. §Also known as myocardial fatty foci.