

Meeting abstract

217 Normal human ventricular volume and mass values in children ages 5–10 years using steady state free precession MRI

William Gottliebson*, Amy Tipton, Kan Hor, Robert Fleck, Eric Crotty, Joshua Germann, Lisa Tully and Janaka Wansapura

Address: Cincinnati Childrens Hospital and Medical Center, Cincinnati, OH, USA

* Corresponding author

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Introduction

Cardiac MRI (CMR) has become an important modality for the evaluation of children with both congenital and acquired heart disease. However, because normal value references for ventricular sizes and function in children are extremely limited, many pediatric CMR clinicians have extrapolated adult normal reference value data for comparison to their clinical data.

Purpose

To establish normal values of left and right ventricular volumes and mass in healthy child volunteers ages 5–10 years using steady-state free precession (SSFP) CMR.

Methods

50 healthy volunteer children (26 female) ages 5–10 years (mean age 7.7 years) underwent research CMR using steady-state free precession sequences in a Siemens 3 T Trio magnet. Children were allowed to watch video via a modified MRI-compatible display system (Avotec, Stuart, FL); no pharmacological sedation was used. Standard contiguous non-overlapping short-axis cine data sets from the ventricular apex to the base of the heart were performed both with breath holding and again during free-breathing. For the free-breathing component, the SSFP sequence was acquired with GRAPPA parallel acquisition (acceleration factor = 2); image blurring due to chest motion was suppressed by long term signal averaging (Nex = 4–5). Manual analysis was performed by 2 expert observers using Medis MASS (Leiden, Netherlands) soft-

ware and the modified Simpson's rule to calculate LV and RV volumes and mass. Inter-observer variation was also assessed: 3 "supplemental" expert observers measured the LV and RV parameters on a randomly selected subset of 10 of the subjects (breath-holding sequences only); this data was compared per segment to the data generated on the same subjects by the initial 2 expert observers.

Results

Normal mean values and standard deviations were established for each LV and RV parameter (end-diastolic and end-systolic volumes, and end-diastolic mass), indexed to body surface area (BSA). Comparison of breath-held versus free-breathing studies showed no statistically significant differences between the methods (table in Figure 1) for assessment of any of the parameters. Compared to males, (table in Figure 2) females had slightly larger RV ejection fraction, lower RV end-systolic volume, and were slightly heavier than their male counterparts (all $p < 0.05$). There were no significant differences in left ventricular parameters between the male and female subjects. Inter-observer differences on the subset of 10 subjects showed variations ranging from 7.7% for the indexed LV end-diastolic volume to 44% for the indexed RV mass (table in Figure 3).

Conclusion

Normal indexed values of biventricular chamber sizes and function are provided. Importantly, there were no significant differences in the measurements of free-breathing

parameter	All Subjects (n=50)		
	BH = breath hold		FB = free breathe
	FB	BH	BH and FB
	Mean±SD	Mean±SD	Mean±SD
LVEDVi (ml/m ²)	60.21 ± 8	61.46 ± 9.22	60.81 ± 8.6
LVESVi (ml/m ²)	20.62 ± 6.5	21.78 ± 6.65	21.18 ± 6.57
LVEF (%)	66.23 ± 8.3	64.89 ± 8.16	65.59 ± 8.23
LVMi (g/m ²)	39.1 ± 9.4	38.71 ± 7.53	38.93 ± 8.51
RVEDVi (ml/m ²)	54.8 ± 10.3	56.52 ± 9.39	55.61 ± 9.86
RVESVi (ml/m ²)	17.5 ± 7.8	18.55 ± 6.59	18.01 ± 7.2
RVEF (%)	68.9 ± 10.3	67.76 ± 8.52	68.39 ± 9.49
RVMi (g/m ²)	10.4 ± 5.4	9.38 ± 2.59	9.91 ± 4.29
Height (cm)	127.9 ± 11.3		
Weight (kg)	30.32 ± 12.6		
Age (y)	7.75 ± 1.4		
BSA (m ²)	1.02 ± 0.2		

Figure 1
Normal cardiac MRI values for volumes and ventricular mass are presented for subjects aged 5 – 10 years.

parameter	Females	Males
	n=26	n=24
	Mean±SD	Mean±SD
LVEDVi (ml/m ²)	60.41 ± 6.9	58.64 ± 13.5
LVESVi (ml/m ²)	20.89 ± 4.99	21.59 ± 8.1
LVEF (%)	65.48 ± 7.2	63.65 ± 10.4
LVMi (g/m ²)	41.87 ± 9	43.20 ± 11.8
RVEDVi (ml/m ²)	54.22 ± 8.9	56.81 ± 12.5
RVESVi (ml/m ²)	18.16 ± 6.9	21.75 ± 8.4
RVEF (%)	67.05 ± 10.3	61.92 ± 12.6
RVMi (g/m ²)	11.58 ± 5.6	12.02 ± 5.8
Height (cm)	127.61 ± 12	128.25 ± 10.6
Weight (kg)	31.71 ± 15.6	28.8 ± 8.1
Age (y)	7.81 ± 1.6	7.69 ± 1.2
BSA (m ²)	1.04 ± 0.3	1.01 ± 0.2

Figure 2

Table 3: Interobserver Difference per Segment n = 10 subjects, 5 observers/subject	
Parameter	Mean Interobs Difference (%)
LVEDVi (ml/m ²)	7.69
LVESVi (ml/m ²)	12.01
LVEF (%)	9.46
LVMi (g/m ²)	14.58
RVEDVi (ml/m ²)	10.78
RVESVi (ml/m ²)	22.14
RVEF (%)	16.36
RVMi (g/m ²)	44.21

Figure 3

functional images with signal averaging when compared to breath-held functional images. Inter-observer differences are acceptable for all segments except the RV free wall mass.

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