Effieciency and Reproducibility of the Right Ventricular Long Axis MR Imaging Plane for the Evaluation of the Right Ventricle

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Introduction

Cardiac MRI (CMR) is time consuming, requiring multiple scans and significant post-processing time. Right ventriclular (RV) functional analysis using true transaxial planes has been shown to be more reproducible than short axis (SAX) planes in normal individuals[1,2], and may require fewer slices and less time. A double oblique right horizontal long axis (RHLA) plane that parallels the inferior wall of the RV optimizes imaging of the RV apex, but has not previously been compared to routine SAX (Figure 1). Whether the RHLA plane can be performed using fewer slices and analyzed more quickly than SAX is unknown.

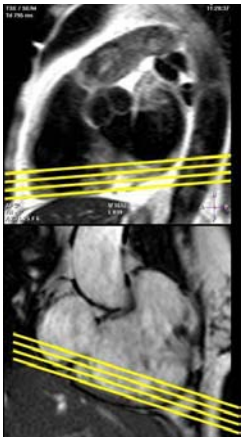

Figure 1. The RHLA Plane. Image planning lines show the plane is parallel to the inferior wall of the RV in orthogonal views.

Methods

Fifteen patients that underwent CMR containing both SAX and double oblique RHLA stacks of breath-held cine steady state free precession images were retrospectively identified. Indications for CMR were rule out ARVD (n=4), evaluate congenital heart disease (n=10), and primary pulmonary hypertension (n=1). Cine SSFP imaging was performed on a Philips Intera 1.5T magnet running release 11 using a dedicated 5 channel cardiac coil (Philips Medical, Best, The Netherlands). Sequence parameters were as follows: TR 3.4 ms , TE 1.7 ms, flip angle 55, 25 cardiac phases, retrospective triggering, 8 mm slices, 2 mm gap, FOV 360 mm, Matrix 160 x 160, and acquired voxel size 2.25 x 2.28 x 8.00 mm. Two blinded reviewers performed quantitative RV analysis from both the RHLA and SAX cine image stacks using manual endocardial edge detection. End diastolic volume (EDV), end systolic volume (ESV), ejection fraction (EF), the number of slices required to cover the RV and the time required to perform the endocardial tracings were obtained for both SAX and RHLA. Statistical analysis compared SAX and HLA RV measurements by paired t-test and Pearson's coefficient. Interobserver variability was estimated by Pearson's coefficient.

Findings

Results are summarized in Table 1. For both observers, the number of slices required to cover the RV, as well as RV contour drawing times (CDT) for a stack of cine RHLA images were significantly less than for the corresponding SAX images. The combined average number of slices used for endocardial tracing and the average CDT were significantly less for RHLA than for SAX imaging. The average EF for Reader 1 and the combined average EF of Readers 1 and 2 were significantly greater for RHLA than for SAX. There was no significant difference in the average RV EF for Reader 2 between RHLA and SAX images. There were not significant differences in EDV and ESV between RHLA and SAX for either observer or for their combined averages.

	RHLA	SAX	p-Value	Pearson Coefficient r
Reader 1				
Slices ± SD	9.6 ± 1.45	10.47 ± 1.51	0.018	0.83
CDT (min) ± SD	6.3 ± 1.91	7.8 ± 2.08	0.001	0.89
EF (%) ± SD	48.32 ± 5.64	44.54 ± 5.72	0.023	0.88
Reader 2				
Slices ± SD	9.53 ± 1.25	10.60 ± 1.45	0.027	0.72
CDT (min) ± SD	9.20 ± 2.11	10.47 ± 2.17	0.042	0.80
EF (%) ± SD	47.91 ± 7.08	44.43 ± 7.35	0.114	0.79
Averages				
Slices ± SD	9.57 ± 1.31	10.53 ± 1.42	0.015	
CDT (min) ± SD	7.77 ± 1.79	9.13 ± 1.63	0.002	
EF (%) ± SD	48.12 ± 6.22	44.49 ± 5.54	0.026	

Table 1. Individual Reader and combined averages of both Reader 1 and 2 number of slices used to calculate RV chamber volume, the CDR, and RV EF measured in RHLA and SAX planes, with their associated p and r values.

Discussion

Functional analysis of the RV using a double oblique axial imaging plane (RHLA) is more efficient and reproducible than the double oblique sagittal imaging plane (SAX). Creating cine image stacks in this orientation will reduce the time required for RV functional analysis and also improve the interobserver variability of these measurements. The difference in measured RVEF between RHLA and SAX planes in this study and closer correlation between right and left ventricular stroke volume in normal individuals studied with axial planes[2] suggests that RVEF is more accurately estimated using the RHLA. Unfortunately, no gold standard is available to us to confirm this hypothesis. With the growing clinical need for surveillance of right heart function, particularly in adult congenital heart disease, technical refinements in functional analysis such as this are important to continue the growth in the clinical application of cardiac MRI. Surveillance of RV function may be optimized by using these data.

Bibliography

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