Journal of Cardiovascular Magnetic Resonance

Oral presentation

Open Access

Feasibility and validation of estimating Global LV functional indices from limited projections using a Modified Simpson's Algorithm

Ramkumar Krishnamurthy*[1], Amol Pednekar[2], Benjamin Cheong[3] and Raja Muthupillai[3]

Address: [1]Rice University, Houston, TX, USA, [2]Philips Health Care, Houston, TX, USA and [3]St. Luke's Episcopal Hospital, Houston, TX, USA
* Corresponding author

from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):O46 doi:10.1186/1532-429X-12-S1-O46

This abstract is available from: http://jcmr-online.com/content/12/S1/O46

Introduction

A stack of 10-12 cine SSFP slices covering the LV are typically acquired to estimate global LV function. But, in instances such as dobutamine stress MR, it is difficult to acquire 10-12 contiguous short axis slices, and acquisition is limited to cine imaging at three short-axis (located at basal, mid and apical portions of the LV), and three long axis orientations (2-, 3- and 4-chamber views) [1]. It is unclear if it is feasible obtain an estimate of global LV function, e.g., EDV, ESV, etc. from these limited views.

Purpose

The purpose of this work is to test the feasibility of developing a modified Simpson's algorithm that can calculate LV volumes from a limited sub-set of cardiac cine MR images (three short-axis views, and one long axis view), and validate the algorithm in human subjects.

Methods

Data acquisition: In 20 subjects (14 M, age: 38+9 years) a set of contiguous cardiac cine SSFP images in the short-axis and in the three standard long-axis orientations were acquired at 1.5 T. The acquisition parameters were: TR(ms)/TE(ms)/flip: 3.2/1.6/60°; acquired voxel-size: 2.5 × 2.5 × 8 mm3; temporal resolution: 40-60 ms; breath-hold time: 5-8 s/slice.

$$V = \left\{ L_1 * A_b + L_2 * \frac{(A_b + A_m)}{2} + L_3 * \frac{(A_m + A_a)}{2} + L_4 * \frac{A_a}{3} \right\}$$

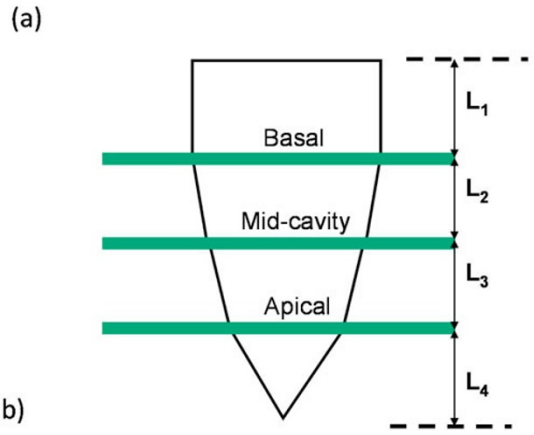

Figure 1
LV Cavity Geometric Model: The LV cavity between the mitral-valve annulus to basal slice was modeled as a cylinder of length L1, the two regions between the basal and mid, and mid and apical slices were moeled as tow cut-cones of lengths L2, and L3, and the apical region between the apical slice and the LV apex was modeled as a cone of length L4. L1 and L4 were calculated directly from one of the long axis views, and the L2, and L3 were calcualted from the inter-slice gap prescribed during acquisition.

Table 1: Bland-Altman Analysis of LV function between Modified Simpson"s method and expert observer

Variable	Expert Observer	Modified Simpson Method	Bland-Altman Percent Mean Bias ± SD (%)
EDV (ml)	155.6 ± 32.9	166.8 ± 35.1	-7.3 ± 6.8
ESV (ml)	65.0 ± 15.4	66.6 ± 15.3	2.4 ± 15.3
EF (%)	58.1 ± 5.2	59.7 ± 6.6	-1.7 ± 6.1

Modified Simpson's algorithm

The LV cavity geometric model is described in Figure 1. The total volume (V) of the left ventricle was calculated from the area (volume) of the LV cavity in the basal (Ab), mid (Am), and apical (Aa) slices by using the following formula in the figure 1a.

Data Analysis

The total LV volume was calculated using the modified Simpson's algorithm, and compared against the LV volume extracted from the expert drawn manual contours on the stack of contiguous short axis slices.

Results

Bland-Altman analysis revealed that the EDV, ESV, and EF estimated using the modified Simpson's algorithm was in close agreement with the values obtained from expert drawn contours on the stack of contiguous short axis slices. The percent mean bias and limits of agreement between the two methods for EDV, ESV, and EF were -7.3 ± 6.8%, 2.4 ± 15.3%, and -1.7 ± 6.1%, respectively, and this range is comparable to inter-and intra-observer variability reported in the literature [2] Table 1.

Conclusion

Total LV volume can be computed from three short-axis slices acquired at the basal, mid, and apical portions of the LV using the modified Simpson's algorithm as described. This approach can pave way for estimating metrics characterizing both regional and global LV function.

References

1. *JMRI* 2006, **24:**499-512.
2. *JMRI* 2008, **28:**39-50.