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Letter to the Editor

Utility of multislice computed tomography with a 64-data acquisition system for four-dimensional volumetric analysis using a pulsating phantom and considering pulsation rate and reconstruction methods

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Abstract

Purpose: To evaluate 64-data acquisition system (DAS) MSCT (Light Speed VCT, GE) at 0.625 mm slice thickness, 0.35 s/rotation, tube 120 kV at 400 mA, ECG-gated for 4-D volumetric analysis, we used pulsating phantoms to measure end-diastolic (EDV) and end-systolic (ESV) volume and ejection fraction (EF) to assess reconstruction methods especially for higher pulsation rates.
Materials and methods: A pulsating device (AZ-631N, Anzai Medical) with contrast material (300 mgI/dl) diluted 10× with saline was moved at 40–110 to-and-fro movements/min. ECG-gated MSCT was performed ×5 per pulsation rate. The EDV and ESV were measured using workstation (Virtual Place Advance Plus, Aze).
Results: The mean EDV and ESV were 98, 97, 97 96, 95, 94, and 101% and 145, 143, 142, 144, 145, 149, 156 and 160%, respectively, compared to the static state. EF was 80, 81, 81, 80, 79, 77, 73, and 76% at 40–110 pulsations/min, when reconstructed by the segmented method, but was improved to 82, 83, 85, and 84% at 80–110 beat/min when reconstructed by the burst method. The latter is therefore more appropriate for higher rates.
Conclusion: This 64-DAS MSCT can measure EDV even at high beat rates (up to 110 beats per minute) compared to the static state. Because ESV tended to be overestimated by approximately 140–160% compared with the static state, EF tended to be underestimated by approximately 73–81% compared with the static state. However, at higher beat rates of >70 beat/min, an appropriate reconstruction method (the burst method) may further improve the accuracy of EF measurement.
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Keywords: Multislice computed tomography; 64-data acquisition system; Four-dimensional volumetric analysis; Pulsating phantom; Pulsation rate; Reconstruction methods

1. Introduction

The accurate assessment of left ventricular (LV) volumes and ejection fraction (EF) is very important for valuable diagnostic, prognostic and therapeutic implications for patients suffering from LV dysfunction [1–3]. Multislice computed tomography (MSCT) provides volume data of the heart, which can be obtained with high temporal and spatial resolution, using less than 1 mm slice thickness including coronary arteries [4–6], LV myocardium [7–11], bypass grafts [12,13] and abnormal collateral systems [14–17]. To date, however, MSCT has been limited in its ability to evaluate cardiac function. The purpose of the present study was to evaluate 64-data acquisition system (DAS) MSCT (Light Speed VCT, GE) at 0.625 mm slice thickness, 0.35 s/rotation, tube 120 kV at 400 mA, ECG-gated for 4-D volumetric analysis, we used

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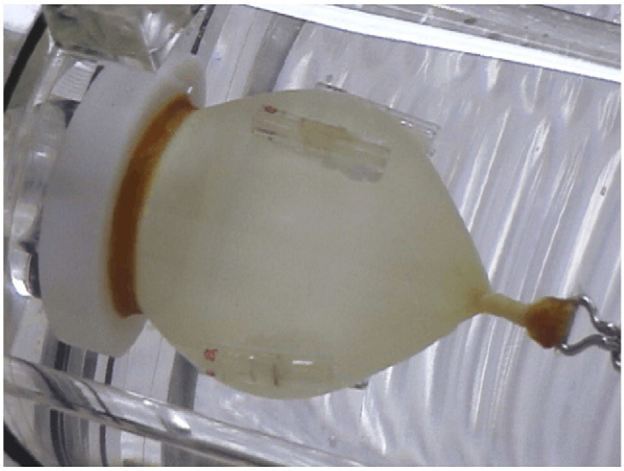

Fig. 1. A pulsating device (AZ-631N, Anzai Medical, Tokyo) is presented. It contained contrast material (300 mgI/dl) diluted 10× with saline, and was moved to-and-fro at rates of between 40 and 110 movements/min.

pulsating phantoms to measure end-diastolic (EDV) and end-systolic (ESV) volume and EF to assess reconstruction methods especially for higher pulsation rates.

2. Materials and methods

A pulsating device (AZ-631N, Anzai Medical, Fig. 1) [18,19] with contrast material (Iomeron 300 mgI/dl, Eizai) diluted 10× with saline was moved at 40–110 to-and-fro movements/min. ECG-gated MSCT was performed ×5 per pulsation rate. 0, 40–70 beat/min was reconstructed only using segment method, 80–110 beat/min was reconstructed by the segment or burst methods. Each motion was divided into 20 frames. The EDV and ESV were measured using workstation (Virtual Place Advance Plus, Aze) and EF was calculated as ED minus ES volume / ED volume × 100 (%). ED was defined as the maximum dilation and ES as the maximum contraction of the pulsating device. ED and ES reconstruction windows were selected on the basis of axial images reconstructed in 5% steps throughout the entire to-and-fro movement. ED and ES phases were identified visually on those images showing the largest and smallest pulsating device cavity areas, respectively.

Fig. 2. The volume-rendered images of the pulsating device of the end-diastolic (A) and end-systolic (B) phase are presented.

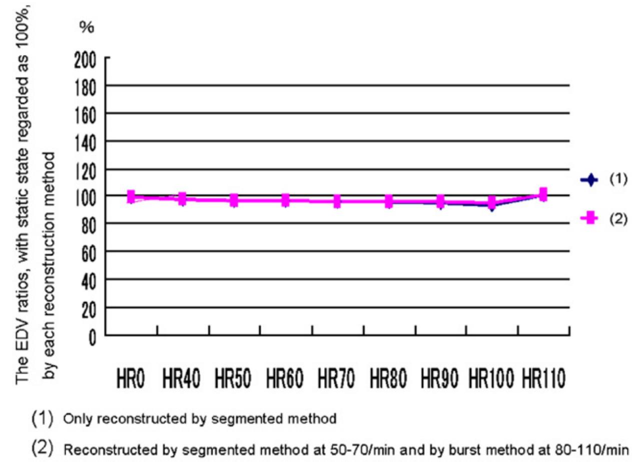

Fig. 3. The relationship between the end-diastolic volume (EDV) ratios, with static state regarded as 100%, by each reconstruction method of balloon and pulsation heart rate (HR) is presented. The EDV ratios, with static state regarded as 100%, were 98, 97, 97, 96, 96, 96, 95, and 101%, respectively at 40–110 beats/min all by the segment method ((1), blue line) and 98, 97, 97, 96, 97, 97, 95, and 101%, respectively at 40–70 beat/min by the segment method, and 80–110 beats/min by the burst method ((2), pink line).

3. Results

The configuration of the pulsating device showed no gaps regardless of its pulsation rate (Fig. 2).

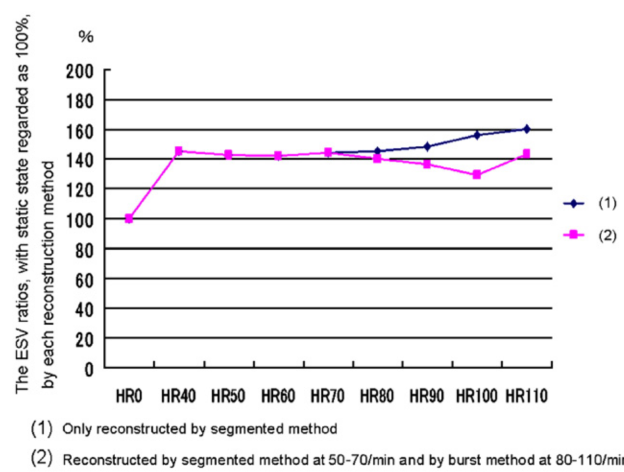

Fig. 4. The relationship between the end-systolic volume (ESV) ratios, with static state regarded as 100%, by each reconstruction method of balloon and pulsation heart rate (HR) is presented. The ESV ratios, with static state regarded as 100%, were 145, 143, 142, 144, 145, 149, 156, and 160%, respectively at 40–110 beats/min all by the segment method ((1), blue line), and 145, 143, 142, 144, 140, 136, 130, and 143%, respectively at 40–70 beat/min by the segment method and 80–110 beats/min by the burst method ((2), pink line). At higher beat rates of >70 beat/min, an appropriate reconstruction method (the burst method) may improve the accuracy of ESV measurement compared with the segment method.

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