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Quantitative 4-dimensional volumetric analysis of left ventricle in ischemic heart disease by 64-slice computed tomography: a comparative study with invasive left ventriculogram

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Abstract

Objective: To elucidate the usefulness of CT in evaluating left ventricular (LV) volumes and ejection fraction (EF) in ischemic heart disease (IHD), we compared 64-slice CT with conventional left ventriculography (CLVG).

Materials and methods: 71 subjects with suspected or confirmed IHD underwent ECG-gated enhanced CT before or after cardiac catheterization. End-diastolic volume (EDV) and end-systolic volume (ESV) of LV were selected in 20 phases of R–R interval of ECG, and data sets were reconstructed to determine EDV, ESV, SV, and EF of LV using a multislice area summation method; in CLVG these parameters were calculated from the right anterior oblique 30-degree projection.

Results: Correlation coefficients between CT and CLVG for EDV, ESV, SV, and EF were 0.759, 0.895, 0.550, and 0.836, respectively ($P<0.01$). In 35 subjects without apical asynergy of LV wall motion, correlation coefficients between CT and CLVG were 0.77, 0.91, 0.63, and 0.87 respectively ($P<0.01$); in 36 subjects, with apical asynergy, the correlation coefficients were 0.751, 0.875, 0.503, and 0.738, respectively ($P<0.01$). The limits of agreement of all parameters were wider in the subjects with apical asynergy of LV wall motion than the subjects without.

Conclusion: There was good correlation between EDV, ESV, SV, and EF estimated by CT and those by CLVG, but CT tended to overestimate EDV and ESV and underestimate EF. In subjects with apical asynergy of LV wall motion, estimates of EF were less correlated between CT and CLVG and the limits of agreement of all parameters were wider than in those without. These discrepancies may come from the capability of CT to estimate LV wall asynergy 3-dimensionally and more accurately.

Keywords: Quantitative 4-dimensional volumetric analysis; Left ventricle; Ischematic heart disease; 64-slice computed tomography; Invasive left ventriculogram

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]. For example, LV volume after myocardial infarction is a strong predictor of mortality and heart failure [4]. With the increased recognition of cardiac remodelling, and the development of therapeutic interventions to mediate this, single or multiple estimates of LV volumes and EF are frequently used to assess an individual's need for, and response to, treatment. Furthermore, many clinical trials use these parameters as a threshold for randomization or as a primary outcome measure. The accurate measurement of LV volumes and EF is therefore important.

Multislice computed tomography (MSCT) provides volume data of the heart, which can be obtained with high

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Table 1
Demographics and baseline characteristics

N	71
Age (years)	67±12
Male subjects, *N* (%)	43 (61)
Height (cm)	158.9±9.9
Body weight (kg)	62.9±14.0
BMI (kg/m^2)	24.6±3.5
Heart rate (bpm)	56±10
Interval between CT and CLVG (days)	42±48
OMI, *N* (%)	40 (56)
Apical asynergy of LV wall motion, *N* (%)	36 (51)
EF of CT (%)	57.8±13.8
EF of CLVG (%)	62.6±11.5

BMI, Body mass index; bpm, beats per minute; CLVG, conventional left ventriculogram; CT, computed tomography; EF, ejection fraction; LV, left ventricular; OMI, old myocardial infarction.

temporal and spatial resolution, within 10 s, using less than 1 mm slice thickness. To date, however, 64-slice computed tomography (CT) has been limited in its ability to evaluate cardiac function. We have implemented a technique for volumetric and functional assessment of the heart by electrocardiogram (ECG)-gated enhanced 64-slice CT. LV volumes and EF were calculated and compared with those obtained from conventional left ventriculography (CLVG), currently the recognized reference standard. It is important to know whether the results of each technique are interchangeable. Several studies have also shown that MSCT can be used to evaluate the patency of not only native coronary arteries but also those surrounded by metallic stents [5–7]. Therefore, if a patient were undergoing MSCT to evaluate the patency of coronary arteries, it would be useful to

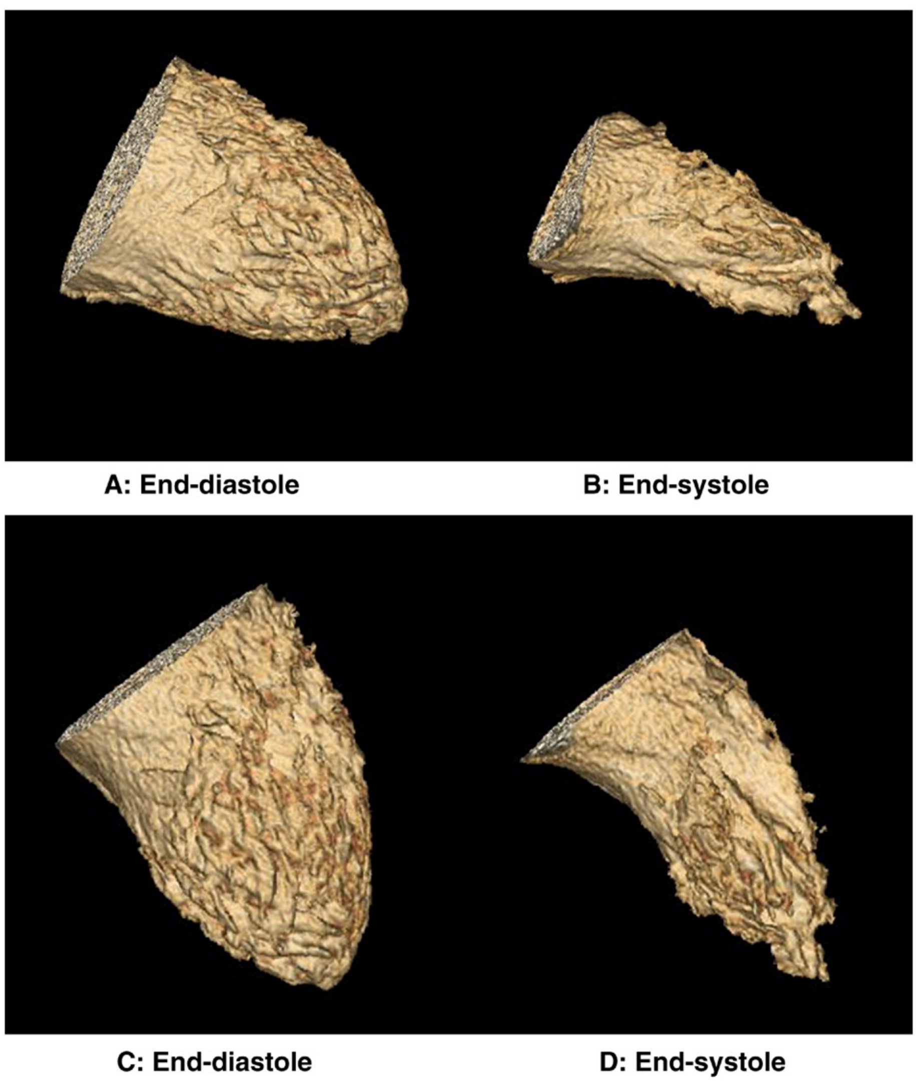

Fig. 1. 3-dimensional images of the left ventricle (LV) using 64-slice computed tomography (CT), in a normal subject who did not have apical asynergy of LV motion, from the right anterior (A and B) and right superior anterior (C and D) oblique directions, in end-diastole (A and C) and end-systole (B and D). End-diastole volume, end-systole volume, stroke volume and ejection fraction were calculated as 105 mL, 42 mL, 63 mL, and 60%, respectively. In comparison to end-diastole, all LV portions had contracted in end-systole.