ELSEVIER

International Journal of Cardiology 136 (2009) 171 – 177

International Journal of Cardiology

www.elsevier.com/locate/ijcard

Evaluation of new automated gated-SPECT and echocardiographic methods for calculating left ventricular volumes and ejection fraction ☆

Peter Gjertsson *, Sofia Ekberg, Milan Lomsky, Li-Ming Gan, Lars Edenbrandt

Department of Clinical Physiology, Sahlgrenska University Hospital, SE-413 45 Göteborg, Sweden

Received 30 November 2007; received in revised form 20 March 2008; accepted 23 April 2008
Available online 13 August 2008

Abstract

Background: Left ventricular (LV) volumes and ejection fraction (LVEF) are assessed using ECG-gated myocardial perfusion scintigraphy (MPS) and echocardiography. We have developed CAFU, a new automated method for the quantification of MPS images. AutoEF software is a new automated method for quantifying echocardiograms (Tomtec research arena). The aim of the study was to compare these new methods with standard methods.

Methods: Patients undergoing clinical MPS were invited to an echocardiographic examination. Eighty-eight patients were included, mean age 64 ± 10 years, 50% men. LV volumes and LVEF from the echocardiographic examinations were calculated using the AutoEF software and calculations according to Simpson's rule. The LV volumes and LVEF from the MPS images were calculated using CAFU, Quantitative gated-SPECT (QGS) and Emory Cardiac Toolbox (ECT).

Results: The MPS methods revealed larger LV volumes and LVEF compared with the echocardiographic methods. CAFU showed an excellent correlation with QGS and ECT (0.91–0.99). The correlations between the MPS and the echocardiographic methods (0.47–0.88), as well as between the AutoEF-assessed values and Simpson's method (0.57–0.87), were lower, however statistically significant. The correlations between the methods were higher for LV volumes than for LVEF.

Conclusion: There was better agreement between LV volumes and LVEF values from the three MPS methods than between those from the two echocardiographic methods. The echocardiographic methods produced significantly lower LV volumes and LVEF compared with the MPS methods. In the clinical situation, LV volumes and LVEF values from different types of examination or different software packages should be treated with caution.

© 2008 Elsevier Ireland Ltd. All rights reserved.

Keywords: Myocardial perfusion scintigraphy; Echocardiography; Left ventricular volumes; Left ventricular ejection fraction; Automated method

1. Introduction

Left ventricular (LV) volumes and function provide valuable information in patients with ischemic heart disease and have also proven to be powerful prognostic indicators [1,2]. Two-dimensional (2D) echocardiography is the most widely used method for assessing LV volumes and ejection fraction (LVEF). The limitations of echocardiography include problems associated with the inadequate delineation of the endocardium and, in some patients, problems with poor echocardiographic windows. 2D echocardiography has shown a good correlation with radionuclide ventriculography when comparing LVEF [3–5]. However, in other studies, LVEF has been shown to differ depending on the method, comparing 2D echocardiography, radionuclide ventriculography and magnetic resonance imaging (MRI) [6]. Gated myocardial perfusion scintigraphy (MPS) has evolved as a modality which enables the simultaneous evaluation of function (LV volumes, LVEF, wall motion and thickening) and perfusion. Different software packages are available for the quantification of gated MPS. QGS (Cedars-Sinai, Los Angeles, CA) [7] and

☆ This study was supported by grants from the Göteborg Medical Society, Göteborg, and Sahlgrenska University Hospital, Göteborg, Sweden.

* Corresponding author. Tel.: +46 31 3428027; fax: +46 31 411735.
E-mail address: peter.gjertsson@vgregion.se (P. Gjertsson).

0167-5273/$ - see front matter © 2008 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ijcard.2008.04.082

the Emory Cardiac Toolbox (ECT) (Emory University, Atlanta, GA) [8] are the most widely used. They have been validated using echocardiography [9,10], radionuclide ventriculography [9,11] and MRI [12–15]. Recent studies have, however, revealed variations in LV volumes and LVEF between different software programs, such as QGS and ECT [16–18].

We have recently presented a new method for quantifying cardiac function (CAFU) as part of the development of an automated method for the integrated interpretation of gated MPS [19]. This method is based on the active shape algorithm. A heart-shaped model was used instead of geometrical approximations. The CAFU method has been validated, showing a good correlation with QGS, but it produced systematically higher values for EDV, ESV and LVEF compared with QGS [20] The CAFU method has also been integrated in a computer based decision support system, which is aiding physicians in the diagnosis of myocardial infarction and ischaemia in MPS studies. Compared with expert interpretation the decision support system has a sensitivity of 89% and a specificity of 96% for the diagnosis of myocardial infarct; a sensitivity of 90% and a specificity of 85% for the diagnosis of ischaemia [21].

A more automated evaluation of cardiac function is now being developed for echocardiography as well. A new automated method for calculating LV volumes and LVEF, the AutoEF software, has recently been developed by the Tomtec research arena (Tomtec imaging systems GmbH, Germany).

In the present study, we wanted to compare the new CAFU MPS method, as well as the new echo-based automatic EF assessment, with both conventional gated MPS methods and with standard echocardiographically derived volumes and LVEF.

2. Materials and methods

2.1. Patients

Consecutive patients referred for clinical MPS at Sahlgrenska University Hospital between 1 February and 30 June 2006 were invited to undergo an echocardiographic examination on a separate day. A total of 88 patients agreed to participate and were included in the study.

The study was approved by the Research Ethics Committee at Göteborg University.

2.2. Gated myocardial perfusion scintigraphy

The gated-SPECT studies were performed using a gated rest ^{99m}Tc-sestamibi protocol. Acquisition began about 60 min after the injection of 600 MBq ^{99m}Tc-sestamibi. Images were acquired with a dual-head SPECT camera (Infinia or Millenium VG, General Electric, USA) equipped with a low-energy, high-resolution collimator. Acquisition took place in the supine position in the step and shoot mode using circular acquisition and a 64 × 64 matrix, zoom factor 1.28, pixel size 6.9 mm with 60 projections over 180°, 40 s per projection. In patients weighing more than 90 kg, the acquisition time per projection was increased to 55 s. During the rest acquisition, the patient was monitored with a three-lead ECG. The acceptance window was opened to ±20% of the predefined R–R interval, except for a very limited number of studies in which a wider acceptance window was used. Other beats were rejected. Each R–R interval was divided into eight equal time intervals. An automatic motion-correction program was used in studies showing patient motion during acquisition. Tomographic reconstruction was performed using filtered back-projection with a Butterworth filter with a critical frequency of 0.52 cycles/cm Nyquist's limits and order 5. No attenuation or scatter correction was used.

Our group has recently presented a new method for quantification of cardiac function, CAFU [19]. The innovative approach with CAFU compared with previously presented methods was the use of the active shape algorithm. The search and delineation of the left ventricle in the three-dimensional (3D) image space is based on a non-geometrical, heart heart-shaped LV model. This model contains information regarding the variation of shape and size of the left ventricles in a reference group of patients, i.e. a geometrical model such as an ellipsoid model or a hybrid cylindric–spheric model used in other toolboxes are not used in CAFU. A heart-shaped model is more likely to fit to myocardial surfaces. In an iterative process, the model is adjusted to optimize the fit with the image data. The CAFU algorithm does not constrain the LV basal motion in this process, which is used by the QGS software. The end-diastolic (EDV) and end-systolic volumes (ESV) of the LV are calculated and the LVEF is calculated from these volumes using the formula: LVEF = (EDV − ESV) / EDV. LV volumes and LVEF were also calculated using the QGS (Cedars-Sinai, Los Angeles, CA) [7] and ECT (Emory University, Atlanta, GA) [8] methods.

2.3. Echocardiography

Echocardiography was performed according to the American Society of Echocardiography, 8 ± 10 days (range − 16–45) after the MPS, using an Acuson Sequoia (Siemens, Mountain View, CA, USA). From the apical four- and two-chamber views, the LV EDV and ESV were derived using a new automated method for the quantification of echocardiograms, the AutoEF software developed by the Tomtec research arena. The mean EDV ((EDV 4-chamber view + EDV 2-chamber view) / 2) and ESV ((ESV 4-chamber view + ESV 2-chamber view) / 2) were calculated and, from the mean volumes, the LVEF was calculated ((EDV_{mean} − ESV_{mean}) / EDV_{mean}). The EDV, ESV and LVEF were also calculated according to the bi-plane Simpson's rule [22].

2.4. Statistical analysis

Data are shown as the mean ± standard deviation (SD). The mean values of EDV, ESV and LVEF produced using different methods were tested using a paired *t*-test. Bland–Altman analyses were used to compare calculations of EDV,

Download English Version:

https://daneshyari.com/en/article/2932647

Download Persian Version:

https://daneshyari.com/article/2932647

Daneshyari.com