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Determination of left ventricular ejection fraction by gated ^{99m}Tc -MIBI G-SPECT in patients with takotsubo syndrome — comparison with echocardiography

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Abstract: Background: Echocardiography is the first exam to establish the myocardial function in patients with takotsubo syndrome (TTS). However, ECG-Gated Myocardial Single-Photon Emission Tomography (G-SPECT) also allows to calculate left ventricular ejection fraction (LVEF) and can be useful in early stadium of TTS.

Aim: To compare LVEF obtained from ^{99m}Tc -MIBI G-SPECT and echocardiography in patients with TTS.

Material and Methods: Study population: 20 patients in medium age 77 (62–89) with TTS were included. In all patients ^{99m}Tc -MIBI G-SPECT and echocardiography was performed on the same day.

Results: LVEF measured by G-SPECT and echocardiography ranged from 34 to 83% and 38 to 69%, respectively. The LVEF values for ECHO were significantly lower than for SPECT. The correlation between the LVEF was $r = 0.76$. The calculated correlation coefficient (r) for linear regression analysis was 0.64. The following equation shows the approximate interdependence of both LVEF calculations: $\text{LVEF}_{\text{GSPECT}} = 10.35 + 0.93 * \text{LVEF}_{\text{Echo}}$.

Conclusion: G-SPECT tends to overestimate LVEF compared to echocardiography so these imaging techniques should not be used interchangeably. Calculated equation should be used for comparison of LVEF.

Key words: myocardial diagnostic imaging, nuclear imaging, radioisotopes, SPECT perfusion imaging, takotsubo syndrome.

Background

Echocardiography is the first exam to monitor the myocardial function in patients with takotsubo syndrome (TTS) and its role is well established [1]. Nevertheless, scintigraphic techniques are contributing significantly to diagnosis, treatment planning and the prognosis in TTS [2]. ECG-Gated Myocardial Single-Photon Emission Tomography (G-SPECT) allows to calculate left ventricular ejection fraction (LVEF) and can be useful in early stadium of TTS [3]. ^{99m}Tc -MIBI G-SPECT provides an unique opportunity to assess both regional perfusion and function simultaneously during a single study. This technique also assures highly reproducible assessment of LVEF.

Aim

The aim of this study was to compare LVEF obtained from ^{99m}Tc -MIBI G-SPECT and echocardiography in patients with TTS.

Material and Methods

Study population: 20 patients (18 women, 2 men) aged 77 (62–89) years with TTS were included. In all patients ^{99m}Tc -MIBI G-SPECT was performed within 10 days from onset of the symptoms. On the same day echocardiography was performed as well. The baseline characteristic of the study cohort is summarized in the Table 1.

Table 1. Patient's demographic and clinical characteristic.

Age (years)	77 (62–89)
Female (%)	90
BMI (kg/m ²)	25 (20–34)
Systolic blood pressure (mmHg)	131.5 (70–160)
Diastolic blood pressure (mmHg)	75 (50–115)
Heart Rate (bpm)	82.4 (60–105)
Laboratory parameters	
TnI at admission (ng/ml)	2.4 (0.2–10.9)
TnI max (ng/ml)	3.09 (0.4–12.55)
CK MB at admission (ng/ml)	8.42 (2.1–23.8)
CK MB mass max (ng/ml)	10.94 (2.1–26.1)
CRP at admission (mg/l)	7.03 (0.2–35)
CAD risk factors	
Smoking (%)	30
Hyperlipidemia (%)	65
Diabetes mellitus (%)	30
Hypertension (%)	10
Family history of CAD (%)	10

^{99m}Tc -MIBI G-SPECT:

SPECT data gated in eight time bins were acquired 60 min after intravenous administration of 500–740 MBq technetium-99m MIBI during rest perfusion scintigraphy.

Examination was performed with the use of dual-head Symbia T6 by SIEMENS SPECT/CT hybrid device. Data acquisition started in 60–80 min after radiopharmaceutical injection. A parallel hole, LEHR (low energy high resolution) collimators were used. A 128×128 matrix were used and 60 images were acquired over 1800 with 20 s per view, reconstructed by use of the filtered back projection technique (Butterworth filter, cut off 0.40 order 5). Global LVEF was calculated from G-SPECT rest images using the full automatic algorithm (QGS-SPECT developed at Cedars-Sinai [4]).

Echocardiography:

2-dimensional transthoracic echocardiography (TTE) was performed on the day of SPECT study in the Echocardiography Laboratory certified with grade C accreditation of the Section of Echocardiography of the Polish Cardiac Society on EPIQ 7 Ultrasound Machine (Philips Medical Systems, Andover, MA, USA) or on iE33 Ultrasound Machine (Philips Medical Systems, Andover, MA, USA). LVEF was calculated using Simpson's method and compared with the results of LVEF assessed by nuclear imaging.

Statistical analysis

The Statistica for Windows statistical package was used for data analysis. Data were expressed as mean \pm SD or total %. Analysis of variance (ANOVA) was used to compare the mean values. The linear regression analysis was done, with intercept and slope parameters and correlation coefficient calculations.

The mean values of LVEF were assessed for significance using a Wilcoxon signed-rank test for comparison of two related samples with the application of correlation and regression analysis. The correlation coefficient (r) were calculated. Significant differences were defined as values $p < 0.05$.

Results

The LVEF measured by G-SPECT ranged from 34 to 83%. The corresponding values for echocardiography ranged from 38 to 69% ($p = 0.02$). The LVEF values for ECHO were significantly lower than for SPECT. The correlation between the LVEF of gated SPECT and the LVEF of echocardiography was $r = 0.76$.

Figure 1 shows a plot of the G-SPECT LVEF values against LVEF calculated from echocardiography.

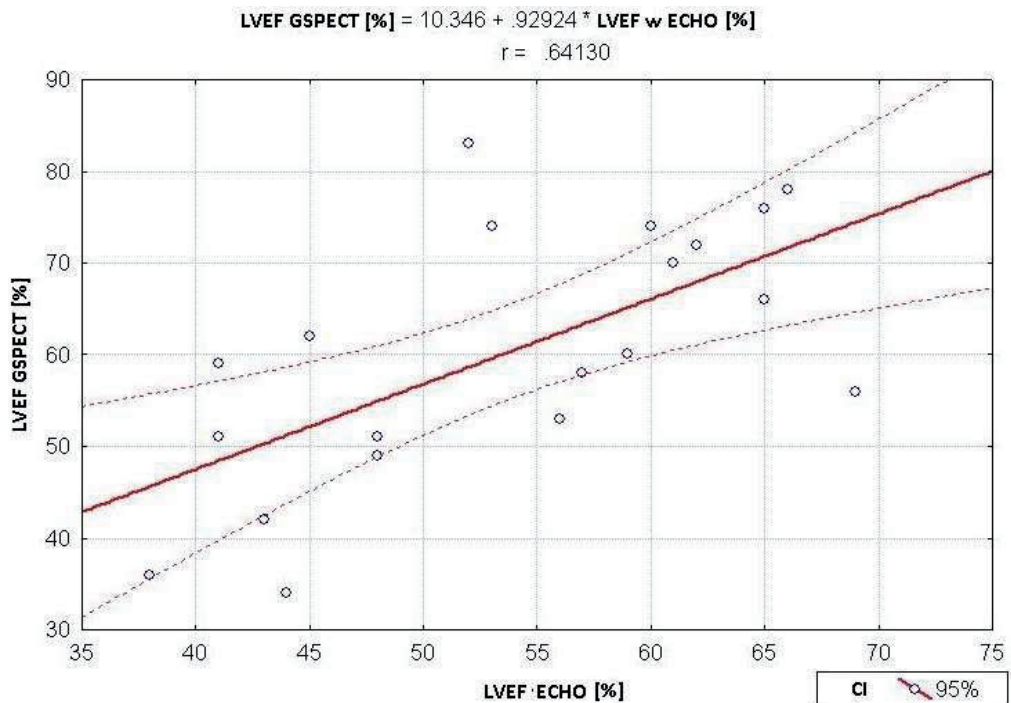


Fig. 1. Correlation analysis of LVEF (%) from G-SPECT and LVEF (%) from echocardiography.

The calculated correlation coefficient r for linear regression analysis was 0.64. The intercept parameter was 10.35. The slope parameter was 0.93. The following equation shows the approximate interdependence of both LVEF calculations:

$$\text{LVEF GSPECT} = 10.35 + 0.93 * \text{LVEF Echo}$$

Discussion

The function of the left ventricle in patients with TTS is routinely assessed by echocardiography. However, other imaging techniques are also used in the diagnostic approach. In previous studies there was wide agreement limits for LVEF assessment by TTE and cardiac magnetic resonance (CMR) therefore that both methods are not interchangeable. Moreover, an underestimation of LVEF by MPI SPECT in comparison to CMR has been reported previously [5].

G-SPECT is one of the method performed in TTS patients during the diagnostic course and in follow-up period. SPECT/CT allows for simultaneous assessment of perfusion and calcium score calculation. Performing SPECT study in gated mode allows additionally for assessment of functional parameters [3]. In our hospital

G-SPECT plays important role both in diagnostic algorithm in patients with coronary artery disease (CAD) and in follow up studies. G-SPECT study is safe, iodine contrast is not required and we have not reported any side effects. Because clinical symptoms, electrocardiographic changes and laboratory parameters in patients with TTS can be similar to patients with acute myocardial infarction (AMI), therefore it is difficult to distinguish TTS from AMI. Although echocardiography is recommended study to monitor the morphology and function of the ventricles in patients with TTS, LVEF calculations using G-SPECT performed usually in early period are also often available. The comparison of LVEF data obtained by various techniques must be performed with caution since they are acquired using non-direct methods of estimation. There are many obvious reasons that explain the differences in the measurements of the LVEF between these two techniques. The variability in LVEF is attributable to differences in the method of imaging and the automatic algorithms [6]. There is an important difference in the positioning of the myocardial cavity and method used for data calculations. The main limitations of echocardiography are its operator-dependence and poor reproducibility. Scintigraphy, on the contrary, provides good reproducibility using mainly automatic procedures, but there are cardiac and respiratory motion artifacts during SPECT. This resulted in significant variability between the results of each analysis. Moreover the different software used to the data analysis causes often discrepancies in the calculations. Even the same study data evaluation with the use of different parameters are often showing differences [7]. Therefore it is recommended to use the same technique to obtain basic and follow-up LVEF in one patient.

Comparisons of measurements of LVEF between different modalities [8, 9] and software within one modality [10] are already investigated. Moreover the concordance between non-invasive LVEF estimation techniques is various in different medical centers, which may be a result of the different study populations. Nevertheless the hospital ability and physician experiences are the main reason for choosing the method of LVEF calculation [11, 12], so the comparison of the own data is in our opinion reasonable. The calculated equation allows comparing the LVEF assessed by echo and SPECT if necessary.

Conclusions

1. G-SPECT has been used to measure LVEF, and the result correlated well with results from echocardiography.
2. G-SPECT tends to overestimate LVEF compared to echocardiography
3. It is important to use only one technique for LVEF measurement in follow up studies.
4. Calculated equation should be used for comparison of LVEF obtained with various modalities: echocardiography and G-SPECT.

5. Despite the observation that G-SPECT was well correlated with echocardiography for assessing left ventricle function, variation was observed between the two imaging modalities, and so these imaging techniques should not be used interchangeably.

Conflict of interest

None declared.

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