New method for accurate estimations of LV function for small hearts

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Electrocardiography (ECG)-gated myocardial perfusion single-photon emission computerized tomography (SPECT) has played an important role in assessments of myocardial perfusion and function.^{1,2} These assessments provide important information about patients' prognoses and treatment effects in various cardiovascular diseases. Various functional parameters including the left ventricular (LV) volume and left ventricular ejection fraction (LVEF) have been well validated.³ However, there are some limitations regarding the quantification of the LVEF by gated myocardial perfusion SPECT. Each functional parameter may vary depending on the SPECT reconstruction methods, reconstruction filters, and software application.^{4–6} The relatively low spatial resolution of nuclear cardiology images may make it difficult to visualize small objects, such as the LV cavity of a small ventricle, particularly at end-systolic phase. Consequently, the left ventricular end-systolic volume (LVESV) is underestimated and the LVEF is overestimated.⁷

The authors' group recently introduced a volume-dependent edge correction algorithm that is used to reduce the errors in ESV and EF estimations of small hearts.⁸ The present study extended this software application for gated myocardial perfusion SPECT in pediatric patients (The present study). The study group consisted of 66 pediatric patients (ages 6–15 years with the mean age of 11.9 years) in whom either malignant

bone or soft-tissue tumors were histologically diagnosed. The volume and LVEF calculations based on echocardiography were used as a gold standard. Although the LVEF was significantly higher when obtained using quantitative gated SPECT-filtered back projection (QGS-FBP) without resolution correction compared to the results obtained by an echo study, no significant differences in the LVEF were seen between the results from the cardioREPO-OSEM (ordered subset expectation-maximization) with resolution correction (RC) and those from the echo study. Thus, they concluded that the small heart effect may be minimized for LV functional analyses when the OSEM algorithm was used with RC with the cardioREPO algorithm.

The present findings supported the previous results obtained by both a phantom study and clinical applications for pediatric patients. The accurate estimation of LV function is of clinical importance particularly for pediatric patients with a malignancy who may require repetitive cardiotoxic chemotherapy.^{9–11} When LV function is accurately estimated with this new method, gated perfusion SPECT has potential for monitoring LV function. In addition, this new method using the cardioREPO-OSEM algorithm with resolution correction provided high-quality myocardial perfusion images that may provide a better delineation of endocardial borders for LV volume calculation.⁶

One may argue whether gated perfusion studies can replace gated blood pool studies. Since a gated myocardial perfusion study may provide both perfusion and functional information with an accurate estimate of LV volume and function, the findings of the study provide additional important information for monitoring the cardiac status during chemotherapy for pediatric patients with malignant diseases.

There are a number of concerns regarding the present study. First, the gold standard volumes were derived from the 'old-fashioned' M-mode echocardiography, under the assumption of a spheroid shape. Such a comparison seems to be rather weak. It would be better to compare

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the results from three-dimensional echocardiography, or MRI. This would be particularly critical when such a new method is applied for various cardiovascular diseases with non-spherical shapes for comparison.

Second, the authors mainly focused on LVEF estimation rather than actual volumes. The LVEF is the final product of both the end-diastolic volume (EDV) and the ESV, and thus an actual volume calculation should be more concerned, particularly for ESV estimations in small hearts. When both the ESV and EDV are underestimated, the LVEF might become pseudo-normalized.

In addition, the authors used four different methods for the reconstruction and edge detection for volume calculation, including QGS-FBP and the cardioREPO-OSEM algorithm with and without RC. We wonder how much improvement in volume calculation can be obtained just by RC with the same reconstruction algorithm. We would also like to determine whether such resolution correction may be better fitted with QGS-FBP, or cardioREPO-OSEM. This paper showed the correlation of ESV value by four different methods. None of them showed a close correlation with the echo study results (Fig. 4), despite the close results of LVEF by cardioREPO-OSEM with resolution correction. Again, it should be kept in mind that the LVEF is the final product of the EDV and ESV.

Although the estimation of LV volumes and functions with limited spatial resolution gated SPECT has a number of limitations, this should be a good start for more accurate estimates of LV functions in small hearts, using suitable reconstruction and an RC algorithm. Furthermore, it would become a method of choice for monitoring LV function after repetitive cardiotoxic chemotherapy if this new method provides accurate estimate of LV functions with lower injected dose to pediatric patients.

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