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Original article

Reduced variability of visual left ventricular ejection fraction assessment with reference images: The Japanese Association of Young Echocardiography Fellows multicenter study☆

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ABSTRACT

Background: Visual estimation of left ventricular ejection fraction (LVEF) is widely applied to confirm quantitative EF. However, visual assessment is subjective, and variability may be influenced by observer experience. We hypothesized that a learning session might reduce the misclassification rate.
Methods: Protocol 1: Visual LVEFs for 30 cases were measured by 79 readers from 13 cardiovascular tertiary care centers. Readers were divided into 3 groups by their experience: limited (1–5 years, $n = 28$), intermediate (6–11 years, $n = 26$), and highly experienced (12-years, $n = 25$). Protocol 2: All readers were randomized to assess the effect of a learning session with reference images only or feedback plus reference images. After the session, 20 new cases were shown to all readers following the same methodology. To assess the concordance and accuracy pre- and post-intervention, each visual LVEF measurement was compared to overall average values as a reference.
Results: Experience affected the concordance in visual EF values among the readers. Groups with intermediate and high experience showed significantly better mean difference (MD), standard deviation (SD), and coefficient of variation (CV) than those with limited experience at baseline. The learning session with reference image reduced the MD, SD, and CV in readers with limited experience. The learning session with reference images plus feedback also reduced proportional bias. Importantly, the misclassification rate for mid-range EF cases was reduced regardless of experience.

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Conclusion: This large multicenter study suggested that a simple learning session with reference images can successfully reduce the misclassification rate for LVEF assessment.

Introduction

Precise and reliable echocardiographic assessment of left ventricular ejection fraction (LVEF) is needed for clinical decision-making. Echocardiographic guidelines recommend that EF be assessed by the biplane method of disks or 3-dimensional echocardiographic method, and then the measurement confirmed by visual estimation [1,2]. Even if the guidelines showed that we should be using measured EF, visual estimation of LVEF is widely applied to confirm quantitative EF in daily clinical work. Visual estimation of LVEF is an important component of determining LV function in all institutes.

Originally, visual assessment was subjective, and variability could be influenced from observer experience. Several institutes had various readers with a wide range of experience levels. Because a large variability in LVEF measurements can occur at different centers, therapies may be confounded when decisions are made on the basis of LVEF [3,4]. There might be a fundamental problem with interinstitutional agreement regarding LVEF in both clinical and research fields. An effective intervention for reduction in variability in LVEF is needed [5,6]. In this paper, we present a simple approach to assessing and improving the quality of visual estimation of LVEF in a large group of echocardiographic laboratories. We hypothesized that the degree of experience affects the variability of visual LVEF assessment and that a learning session might reduce the misclassification rate. Our aim of this study was to compare the inter-observer variability among the groups with a wide range of experience, and assess the utility of the learning sessions to reduce the misclassification rate.

Methods

Patient population

Pre- and post-learning session assessments and analysis were performed in this study (Fig. 1). A total of 13 cardiovascular tertiary care centers participated. Of the 79 voluntary observers participating in the full exercise, 45 sonographers and 34 cardiologists with various levels of echocardiographic experience were included. All participants were blinded to each other's interpretation. Datasets were blinded, stored digitally, and contained apical 4-chamber, 2-chamber, and long-axis views of patients who had undergone clinically-indicated standard transthoracic echocardiography using commercially available machines (iE33; Philips Healthcare, Amsterdam, The Netherlands, and Vivid E9; GE Healthcare, Waukesha, WI, USA). We have selected three apical views for this study. A total of 50 datasets from patients in sinus rhythm were included in the analysis. There were 20 cases with ischemic cardiomyopathy, 20 cases with non-ischemic cardiomyopathy, and 10 cases with hypertension or diabetes. All images were scored for image quality on the basis of visualization of the LV walls and endocardium: 1 = excellent acoustic detail, 2 = good acoustic detail, 3 = adequate acoustic detail, and 4 = technically difficult study with poor or inadequate visualization of LV walls and/or endocardium. To avoid any bias, no clinical data about the cases were provided. Readers were required to provide visual estimates of LVEF as single integers and were blinded to one another's interpretations. All data were collected on an identified answer sheet with each case coded separately. The investigation conformed to the principles outlined in the Declaration of Helsinki, and each participating center conformed to local ethical regulations. The Institutional Review Board of the center of this study (Tokushima University Hospital) approved this study protocol.

Protocol 1. Visual LVEF for 30 cases was estimated by 79 readers from 13 tertiary care centers. Readers were divided into three groups by tertile experience: limited (1–5 years, $n = 28$), intermediate (6–11 years, $n = 26$), and highly experienced (12-years, $n = 25$). All readers interpreted at least 200 transthoracic echocardiography cases/year. Averaged visual LVEF measurement was calculated from 13 highly experienced readers of each center among 79 readers as a reference value in each case. These reference values were compared with each visual LVEF measurement from 3 different experience groups for the assessment of concordance and accuracy.

Protocol 2. After the first session of baseline assessment, two types of learning interventions were conducted. Each participant was randomized into either reference images alone or feedback plus reference images groups using a computer generated random sequence by Microsoft Excel. The learning session with reference images alone consisted of presentation of 6 selected reference cases, which were examples of LV function with actual values (LVEFs equal to 20%, 30%, 40%, 50%, 60%, and 70%). There was no focal asynergy of the LV in the reference images. The values of 6 selected reference cases were determined by the averaged visual LVEF values of 13 highly experienced readers from each center. The reference values were confirmed using cardiac magnetic resonance imaging by one experienced reader. The learning session with feedback plus reference images consisted of presentation of reference cases and self-learning sending the specific feedback sheets to individual participants (Supplement Fig. 1). The specific feedback sheet was a summary of their LVEF estimates compared to the reference values using Bland–Altman plots including mean

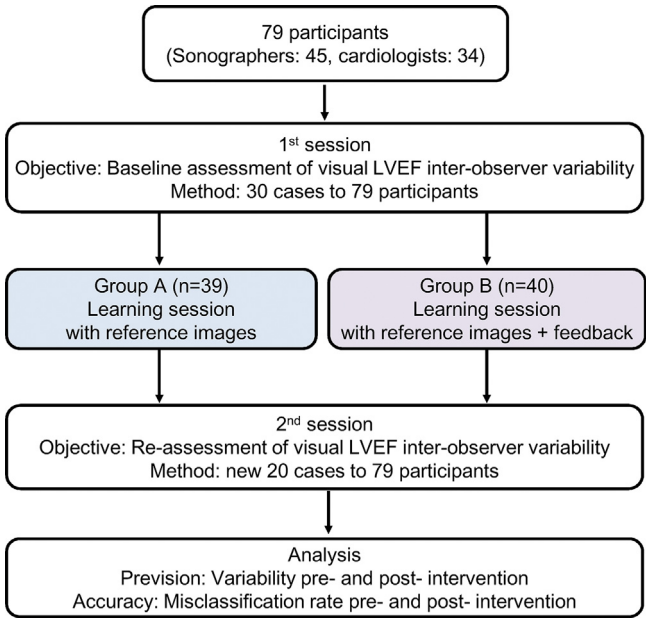

Fig. 1. Study design flowchart for the assessment of visual left ventricular ejection fraction (LVEF).

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