Evaluation of *syngo* Auto Ejection Fraction Software

Kevin Wei, MD

Cardiovascular Division, Oregon Health & Sciences University, Portland, OR

Background

The evaluation of left ventricular (LV) systolic function is an important prognostic indicator in patients with cardiovascular disease. For example, the outcome of patients with congestive heart failure and significant LV dysfunction has been shown to improve with implantation of automated internal cardioverter defibrillators and biventricular pacemakers. Determination of LV ejection fraction (EF) has become more important as the implantation of such devices relies on this measurement. Echocardiography is one of the most commonly used modalities for this purpose. Multiple methods have been developed for quantification of LVEF using echocardiography, but most laboratories do not routinely use these methods because they require time consuming off-line planimetry. Instead, they report LVEF based only on subjective visual interpretations of studies - a practice which is associated with significant inter- and intra-observer variability. Siemens Medical Solutions USA has developed a software program (*syngo*® Auto Ejection Fraction) that can quantify LVEF without manual tracing. The purpose of this study was to evaluate the performance of this software compared to traditional manual planimetry methods.

Methods

A total of 50 consecutive echocardiographic studies obtained with an ACUSON Sequoia system were used for the evaluation. Digital clips of the apical 4- and 2-chamber views were transferred to the hard drive of a Sequoia system with *syngo* Auto EF software. Digital cine-loops from each view were reviewed, and a visual estimate of LVEF by an expert reader was determined. The time required to determine visual LVEF was recorded (Tvis).

The Auto EF program was then applied to each cineloop, and the time required to operate the program and for a LVEF value to be generated was recorded (Tauto). The diastolic and systolic endocardial traces using progressive pattern-recognition of Auto EF were reviewed by an expert, along with the calculated LVEF. If the expert reader disagreed with the contours and/or LVEF from Auto EF, then the contours were manually adjusted. The time required for review and adjustment of Auto EF was also recorded (Tadj). The total time for Auto EF to generate a LVEF was considered the sum of the initial time to run Auto EF and the adjustment time of the expert (Tauto total = Tauto + Tadj).

The gold standard for LVEF in this study was manual planimetry of endocardial borders from both the apical 4- and 2-chamber views performed by well-trained sonographers. LVEF was quantified using the single-plane area-length method. All tracings were verified by the expert, and adjustments to the tracings were made if required, according to standard operating procedures for our laboratory. The time required for manual planimetry by the sonographer (Tman), and adjustment time by the expert were recorded (Tadj). The total quantification time was the sum of these 2 times (Tman total = Tman + Tadj). All planimetry was performed blinded to the results of visually-estimated LVEF data or EF obtained from *syngo* AutoEF.

Statistics

Data are expressed as mean ± SD. Comparisons between 2 stages were performed using Student's t-test, while those between > 2 stages were made using repeated measures ANOVA. Correlations were performed using least squares fit regression analysis. Differences were considered significant at $p < 0.05$ (two-sided).

Results

Apical 4- and 2-chamber cineloops from 50 consecutive patients performed using the Siemens Sequoia system were identified for this study. The quality of 5 cineloops was felt to be inadequate for manual quantification of LVEF (the gold standard) by the expert reader. The data from the remaining 95 cineloops are presented in this report. A number studies 24% were performed using Definity (Bristol Myers-Squibb Medical Imaging, North Billerica, MA) to enhance LV endocardial border delineation.

The mean LVEF quantified manually from all clips after adjustment by the expert reader was 64 ± 13% (range 19 - 90%). The Tman total was 129 ± 32 s (range 83 – 230 s).

The mean visually-estimated LVEF by the expert reader was 63 ± 13% (range 10 – 75%). The mean Tvis was 14 ± 5 s (range 5 – 30 s). Tvis was significantly shorter than Tman total ($p<0.001$). As shown in Figure 1, there was a significant correlation between manually-quantified and visually-estimated LVEF ($p<0.001$, $r = 0.81$, SEE = 7.6).

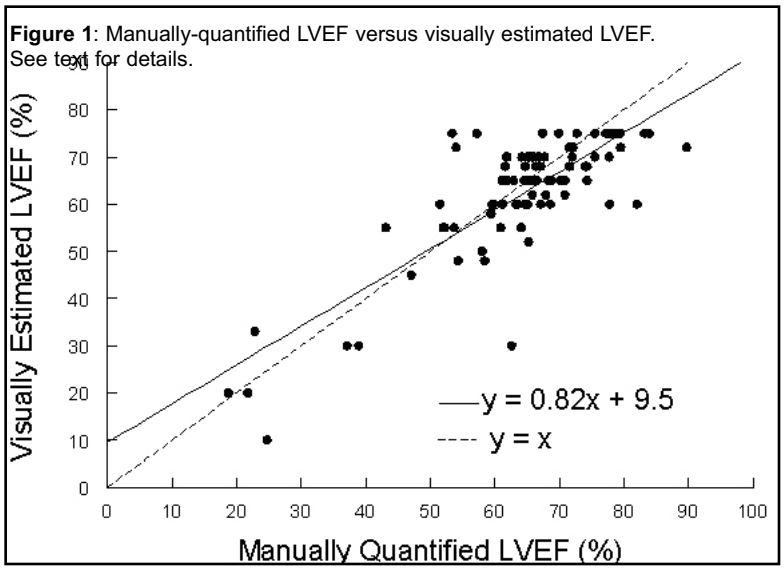


Figure 1: Manually-quantified LVEF versus visually estimated LVEF. See text for details.

The mean LVEF determined using Auto EF was 61 ± 17% (range 9 - 94%). The mean Tauto was 33 ± 29 s (range , which was also significantly shorter than Tman total ($p<0.001$). Similar to visually estimated LVEF, a significant correlation was found between manually-quantified LVEF and Auto EF data (Figure 2, $p<0.001$, $r = 0.60$, SEE = 13.7), but the correlation was not as strong as visually-estimated LVEF and there was a greater scatter.

After manual adjustment of AutoEF by the expert, the mean EF increased significantly to 64 ± 14% (range 13 - 88%). The mean Tauto total was 90 ± 75 s, which was still significantly shorter than Tman total ($p<0.001$). As shown in Figure 3, the correlation of adjusted Auto EF with the gold standard improved ($p<0.001$, $r = 0.77$, SEE = 9.7) compared to pre-adjusted Auto EF. There was only a single cineloop that was not successfully manually adjusted (manually quantified LVEF = 74% versus Auto EF of 9%). Removal of this single point would have resulted in near perfect correlation of adjusted Auto EF compared to the gold standard ($p<0.001$, $r = 0.87$, SEE = 7.1)

Figure 2: Manually-quantified LVEF versus *syngo* Auto EF. See text for details.

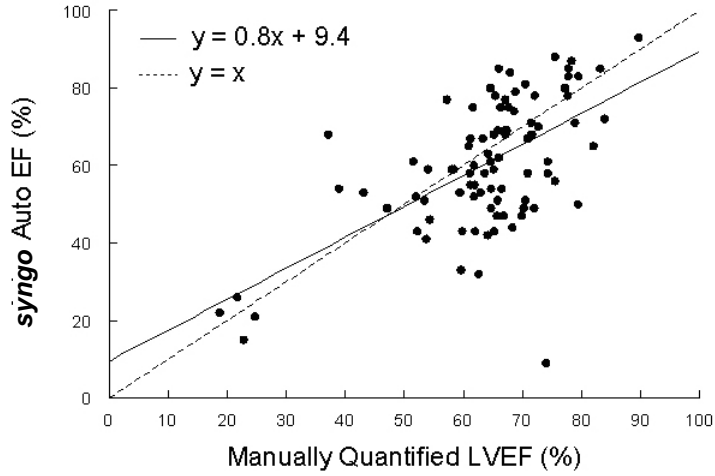
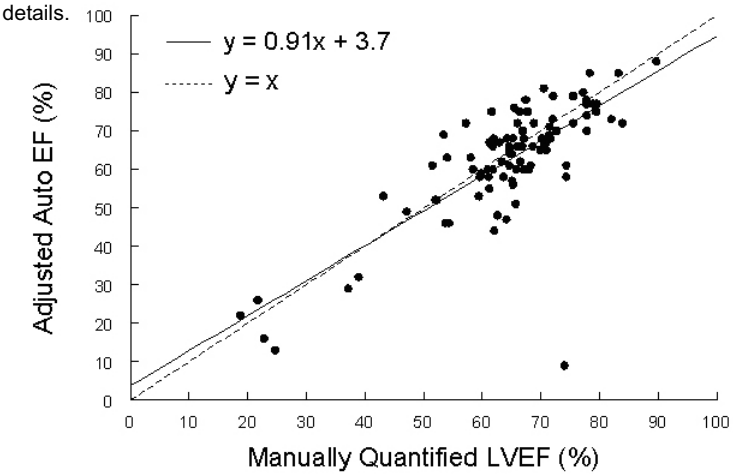


Figure 3: Manually-quantified LVEF versus expert-adjusted Auto EF. See text for details.



Summary

From this data set, *syngo* Auto EF was found to quantify LVEF fairly accurately compared to the manually-quantified gold standard. Auto EF also performs quickly (mean of 30 s). With manual adjustment of Auto EF by an expert reader, there was a significant improvement in the correlation of Auto EF with the gold-standard, and the total time required to run Auto EF and adjust the contours was still significantly shorter than manual tracing.

Address correspondence to:
Kevin Wei, MD
OHSU, UHN62
3181 SW Sam Jackson Park Road
Portland, OR 97239
(P) 503-494-8750
(F) 503-494-8550
Email – weik@ohsu.edu