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Single Versus Standard Multiview Assessment of Global Longitudinal Strain for the Diagnosis of Cardiotoxicity During Cancer Therapy

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ABSTRACT

OBJECTIVES The goal of this study was to compare echocardiographic measurements of global longitudinal strain (GLS) (using 3 apical views) with single-view longitudinal strain (LS, 4- or 2-chamber [4CV_LS and 2CV_LS, respectively]) for detection of cancer-therapy related cardiotoxicity.

BACKGROUND GLS is useful for the detection of cardiotoxicity, but the need for repeated measurements poses a significant burden on busy echocardiography laboratories. A single-view LS measurement, possibly at point of care, could improve efficiency.

METHODS Seventeen international centers prospectively recruited 108 patients (mean age 54 ± 13 years) at high risk for cardiotoxicity as part of the ongoing SUCCOUR (Strain Surveillance for Improving Cardiovascular Outcomes During Chemotherapy) randomized controlled trial. Echocardiography performed at baseline and follow-up were analyzed in a core laboratory setting blinded to clinical information. Peak systolic GLS and LS were measured from raw data. Cardiotoxicity was defined by reduction in left ventricular ejection fraction >0.10 to <0.55 or a relative drop in GLS by ≥12%.

RESULTS Cardiotoxicity developed in 46 patients by either criteria. Baseline and follow-up 2-dimensional left ventricular ejection fraction were 61 ± 4% and 58 ± 5%, respectively ($p < 0.001$). The baseline GLS (-20.9 ± 2.4%) was not different from 4CV_LS (-20.7 ± 2.5%; $p = 0.09$) or 2CV_LS (-21.1 ± 3.1%; $p = 0.25$). The follow-up GLS (-19.5 ± 2.4%) was also similar to 4CV_LS (-19.5 ± 2.6%; $p = 0.80$) and 2CV_LS (-19.7 ± 3.1%; $p = 0.19$). There was good correlation between GLS and 4CV_LS at baseline ($r = 0.86$; $p < 0.001$) and follow-up ($r = 0.89$; $p < 0.001$) and with 2CV_LS at baseline ($r = 0.87$; $p < 0.001$) and follow-up ($r = 0.88$; $p < 0.001$). However, there was 15% to 22% disagreement between GLS and 4CV_LS or 2CV_LS for the detection of cardiotoxicity. The interobserver and intraobserver reproducibility was higher for GLS (intraclass correlation: 0.93 to 0.95; coefficient of variance: 2.9% to 3.7%) compared with either single-chamber-based LS measurement (intraclass correlation: 0.85 to 0.91; coefficient of variance: 4.1% to 4.8%).

CONCLUSIONS Although there was good correlation between GLS and single-view LS measurements, single-view LS measurement led to disagreement in the diagnosis of cardiotoxicity in up to 22% of patients. GLS measurements were more reproducible than single-view LS. GLS based on 3 apical views should remain the preferred technique for detection of cardiotoxicity. (Strain Surveillance for Improving Cardiovascular Outcomes During Chemotherapy [SUCCOUR]; ACTRN12614000341628) (J Am Coll Cardiol Img 2018;11:1109-18) © 2018 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

2CV = 2-chamber view

4CV = 4-chamber view

AUC = area under the curve

CI = confidence interval

GLS = global longitudinal strain (using 3 apical views)

LVEF = left ventricular ejection fraction

LS = single-view longitudinal strain (4- or 2-chamber)

Peak systolic global longitudinal strain (GLS) measured using echocardiography has emerged as a sensitive marker of left ventricular systolic dysfunction. Its use has gained particular interest in the field of "cardio-oncology" to facilitate detection of early cardiotoxicity (1). A 10% to 15% relative drop in GLS early during cancer therapy identifies patients at risk of later reduction in left ventricular ejection fraction (LVEF) or development of congestive heart failure (2–4).

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Standard GLS is calculated from 3 apical images. This method requires careful attention to optimizing 3 views, ensuring consistent heart rate and frame rate during acquisition, and post-processing of 3 datasets. In most cancers, patients receiving cancer therapy require repeated testing to identify cardiotoxicity. There is evidence that reversibility of left ventricular dysfunction is associated with early initiation of heart failure therapy after the onset of cardiotoxicity (5). A single long-axis view could improve efficiency and promote uptake of this technique in busy echocardiography laboratories, or even be applied to imaging approaches at point of care (6), allowing prompt detection of cardiotoxicity (7). Moreover, because cardiotoxicity is believed to be a diffuse process, longitudinal strain (LS) measurements from a single 4-chamber (4CV_LS) or 2-chamber (2CV_LS) view GLS could substitute for traditional GLS measurements. Using such an approach would enable LS measurements to be gathered easily as part of the routine evaluation after each round of chemotherapy, with a higher likelihood of rapid recognition of cardiotoxicity. We hypothesized that single-view LS measurements correlate with GLS, have acceptable measurement reproducibility, and could be used as an alternative to GLS in the detection of cardiotoxicity.

METHODS

PATIENTS. The study cohort consisted of patients recruited to the SUCCOUR (Strain Surveillance During Chemotherapy for Improving Cardiovascular Outcomes) trial. SUCCOUR is a multicenter, international, randomized controlled trial comparing the use of GLS versus LVEF by echocardiography for early detection and management of cardiotoxicity in patients receiving potentially cardiotoxic cancer treatment. Those who have an absolute reduction in LVEF (>0.10 reduction to <0.55) or a relative reduction in GLS (≥12% relative) in the strain arm are treated with a combination of angiotensin-converting enzyme inhibitors and beta-blockers. The primary outcome is a change in LVEF between baseline and the end of 3-year follow-up.

In this baseline substudy, we examined the first 108 patients (enrolled between January 2014 and September 2016), without reference to the outcome standard in the study, and with no knowledge about the patient's randomization status. The measurements in this study were obtained from the core laboratory, which are independent of the GLS or EF analysis being done to guide management in the clinical trial, which are local to the sites. Core laboratory measurements are not sent back to local sites and do not influence clinical management.

ECHOCARDIOGRAPHY. Transthoracic echocardiography was performed before initiation of cancer therapy and repeated every 3 months during treatment. For patients receiving anthracycline-based therapy, the baseline study was performed at the time of initiation of anthracycline; in those receiving anthracycline followed by trastuzumab, the baseline study was performed before trastuzumab initiation but after anthracycline completion. All studies were performed on standard, commercially available echocardiographic systems (Vivid 7 and E9, GE Medical, Milwaukee, Wisconsin).

Apical 2- and 4-chamber views were obtained for calculation of LVEF using the biplane Simpson method. Three long-axis images were recorded with the optimal frame rate (55 to 80 frames/s), stored in raw data format and transferred to the central core laboratory for analysis. Before the start of the study all involved centers participated in a calibration session to ensure uniform technique in image acquisition for strain and EF measurements (8). For this

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TABLE 1 Baseline Characteristics of the Included Patients (N = 108)

Age, yrs	54 ± 13
Female	101 (93.5)
Breast cancer	95 (88.0)
Acute myelogenous leukemia	2 (1.9)
Non-Hodgkin's lymphoma	11 (10.2)
Cancer treatment	
Anthracyclines	108 (100.0)
Trastuzumab	79 (73.1)
Chest radiation therapy	30 (27.8)
Cardiac risk factors	
Diabetes	11 (10.2)
Hypertension	37 (34.3)
Dyslipidemia	22 (20.4)
Smoking	37 (34.3)
History of cardiovascular disease	13 (12.0)
Cardiac medications	
Beta-blockers	8 (7.4)
ACE inhibitors/ARBs	19 (17.6)
Statins	14 (13.0)
Systolic blood pressure, mm Hg	125 ± 15
Diastolic blood pressure, mm Hg	78 ± 15
Heart rate, beats/min	78 ± 10
Left ventricular ejection fraction, %	61.0 ± 3.6
Global longitudinal strain, %	−20.9 ± 2.4

Values are mean ± SD or n (%).
ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker.

study, the baseline echocardiography study (before any cancer treatment or before trastuzumab) and a subsequent study at the time of cardiotoxicity diagnosis (between visits 3 and 6) or the final study during treatment in those without cardiotoxicity were chosen for analysis. All analyses of LVEF (biplane Simpson method), GLS 4CV_LS, and 2CV_LS were performed by an experienced cardiologist (T.N.) in a core laboratory setting at baseline and follow-up, blinded to all patient data and imaging time point. For the analysis of 4CV_LS and 2CV_LS alone, the measurements obtained as part of the GLS measurements by the same observer were used. Strain analysis was performed using EchoPac version 13.0.0 or 201 (GE Healthcare, Milwaukee, Wisconsin).

CARDIOTOXICITY. Cardiotoxicity was defined as an absolute decrease in 2-dimensional EF >0.10 from baseline to <0.55 or a relative GLS decrease by ≥12% consistent with the definition used in the ongoing SUCCOUR randomized controlled trial. The 2-dimensional EF criterion was used to be consistent with all previous publications examining the value of echocardiography to define cardiotoxicity (1,2,9). In addition, 2 sensitivity analyses with different definitions of cardiotoxicity were performed: 1) absolute LVEF decrease >0.10 from baseline to <0.53 and a relative GLS decrease of >15% (to follow the recent American Society of Echocardiography recommendations) (7); and 2) isolated relative reduction in GLS by ≥12% or >15%.

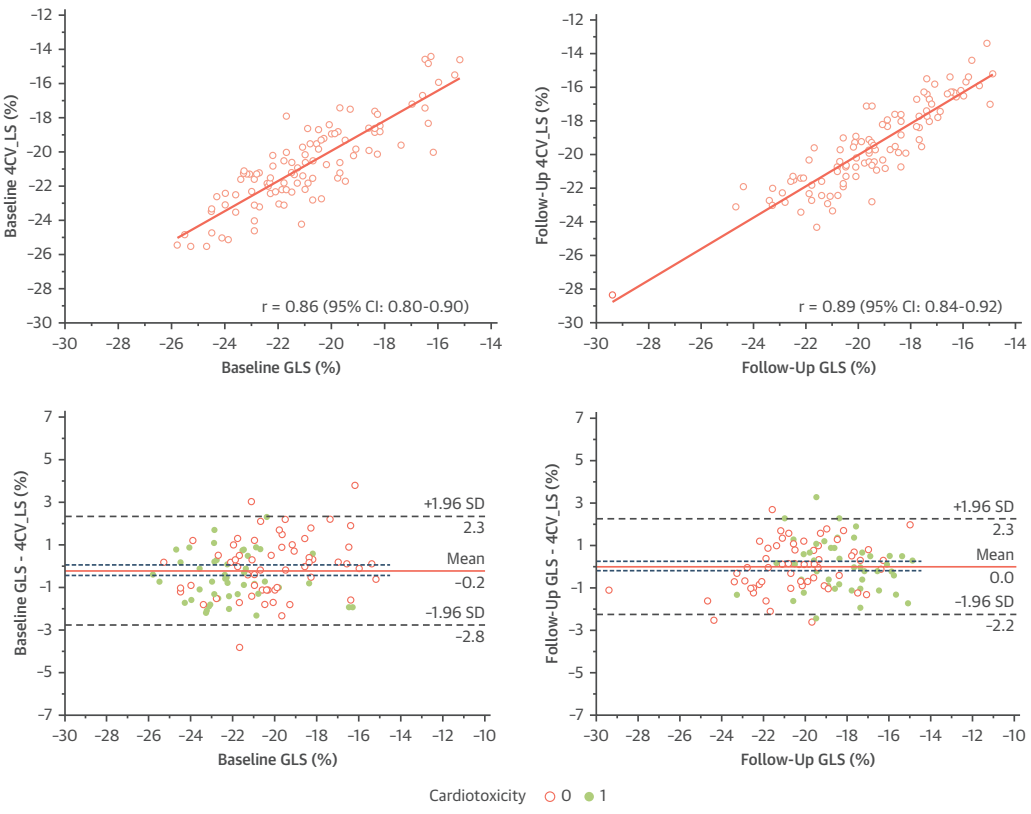
REPRODUCIBILITY. Interobserver and intraobserver reproducibilities of the strain measurements were performed for GLS, 4CV_LS, and 2CV_LS in 20 independent studies. Strain measurements were performed by 2 experienced analysts (T.N. and P.T.) blinded to each other's measurement. The same measurements were repeated by one analyst (T.N.) blinded to previous measurements.

STATISTICAL ANALYSIS. Data are summarized as mean ± SD or median (interquartile range) as appropriate. All data were first assessed for normality based on skewness, kurtosis, and the Kolmogorov-Smirnov test. Relationships between continuous parameters were assessed using Pearson correlation. Independent sample Student's *t*-test or paired *t*-tests were used to compare continuous variables as appropriate. A Bland-Altman plot was used to examine agreement between techniques. In addition, the Cohen kappa value was calculated to assess agreement between GLS and 4CV_LS or 2CV_LS for the development of cardiotoxicity defined based on reductions in strain alone. Diagnostic accuracy was calculated as ([true positive + true negative]/[true positive + false positive + true negative + false negative]). Receiver-operating curves were generated to identify the threshold changes in single-view LS that had the best accuracy for discriminating cardiotoxicity defined using GLS changes alone. Areas under the curve (AUC) were compared using the Hanley and McNeil method. Interobserver and intraobserver reproducibility of the strain measurements are reported as intraclass correlation and coefficient of variation. Statistical analyses were performed with IBM SPSS statistics version 20.0.0 (IBM SPSS Statistics, IBM Corporation, Armonk, New York) and MedCalc version 11.4.2.0 (MedCalc, Mariakerke, Belgium). All p values are based on 2-sided tests, with a p value <0.05 considered statistically significant.

RESULTS

PATIENTS. A total of 108 patients, predominantly women and mostly with a history of breast cancer (Table 1), were included. All patients received anthracycline-based therapy; their high-risk status was mostly attributable to trastuzumab therapy.

FIGURE 1 Comparison of GLS and 4CV_LS at Baseline and Follow-Up



The **top 2 panels** demonstrate linear regression curves comparing baseline **(left panel)** global longitudinal strain (GLS) versus 4-chamber view longitudinal (4CV_LS) strain and follow-up **(right panel)** GLS versus follow-up 4CV_LS. The **bottom 2 panels** are the respective Bland-Altman plots. CI = confidence interval.

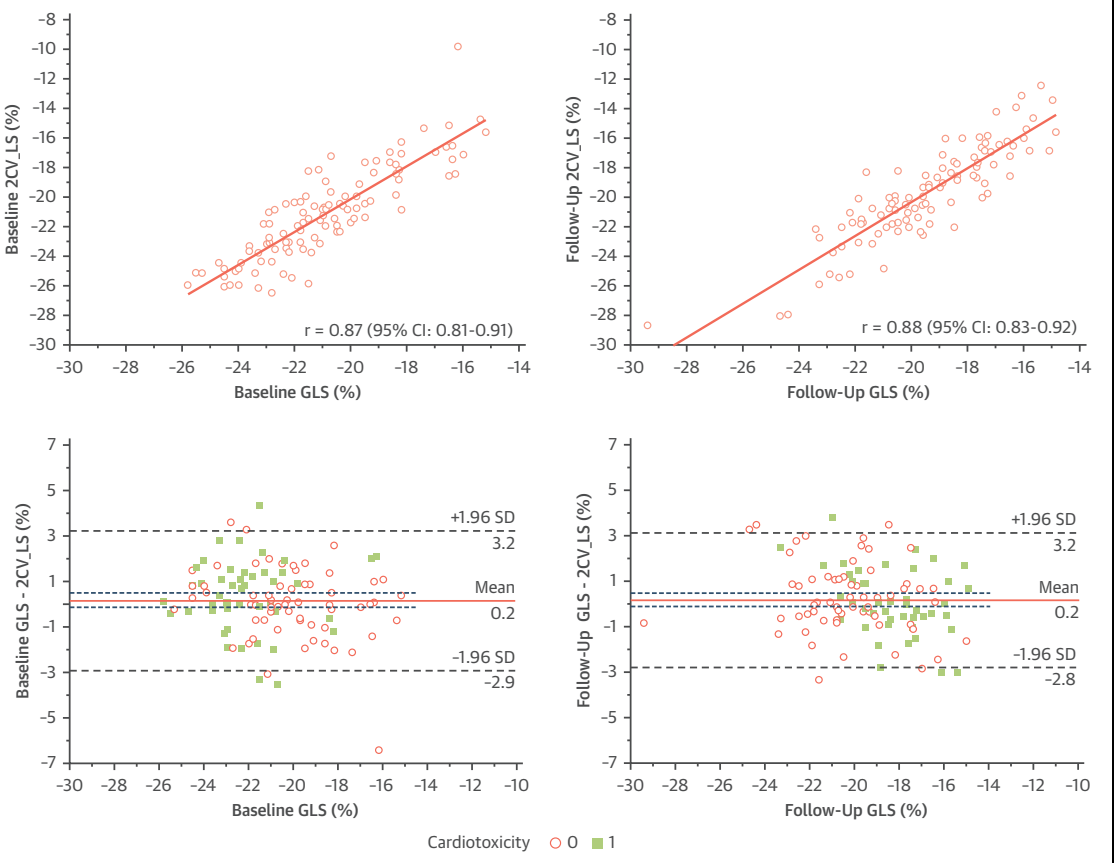
STRAIN AGREEMENT. The mean time period between baseline and follow-up imaging was 5.2 ± 2.6 months. Baseline and follow-up LVEF were 61 ± 4% and 58 ± 5%, respectively ($p < 0.001$). The baseline GLS (-20.9 ± 2.4%) was not different from 4CV_LS (-20.7 ± 2.5%; $p = 0.09$) or 2CV_LS (-21.1 ± 3.1%; $p = 0.25$). The follow-up GLS (-19.5 ± 2.4%) was also not significantly different from the follow-up 4CV_LS (-19.5 ± 2.6%; $p = 0.80$) or 2CV_LS (-19.7 ± 3.1%; $p = 0.19$). The changes in strain from baseline to follow-up were significant by all 3 methods ($p < 0.001$ for all).

There was good correlation between GLS and 4CV_LS at baseline ($r = 0.86$; $p < 0.001$) and follow-up ($r = 0.89$; $p < 0.001$) (Figure 1). Bland-Altman plots demonstrated minimal bias (0.2% at baseline; 0.0% at follow-up) with modest limits of agreement (2.5% and 2.2%, respectively). There was also good correlation between GLS and 2CV_LS at baseline ($r = 0.87$; $p < 0.001$) and follow-up ($r = 0.88$; $p < 0.001$) (Figure 2). Bland-Altman plots demonstrated minimal bias (0.2% at baseline; 0.2% at follow-up) with modest limits of agreement (3.0% and 3.0%).

CARDIOTOXICITY. Three criteria were used for cardiotoxicity. First, using the primary definition (EF >0.10 from baseline to <0.55 or a relative GLS decrease by ≥12%), 46 patients developed cardiotoxicity. Comparing a ≥12% relative change in 4CV_LS versus GLS between baseline and follow-up yielded 15 (14%) false-negative findings and 9 (8%) false-positive findings, resulting in a discordance rate of 22% (Figure 3A), and a diagnostic accuracy of 78%. Comparing 2CV_LS versus the GLS change of ≥12% yielded 13 (12%) false-negative findings and 9 (8%) false-positive findings, resulting in a discordance rate of 20% (Figure 3B) and a diagnostic accuracy of 80%.

Second, using the American Society of Echocardiography suggested definition (absolute LVEF

FIGURE 2 **Comparison of GLS and 2CV_LS at Baseline and Follow-Up**

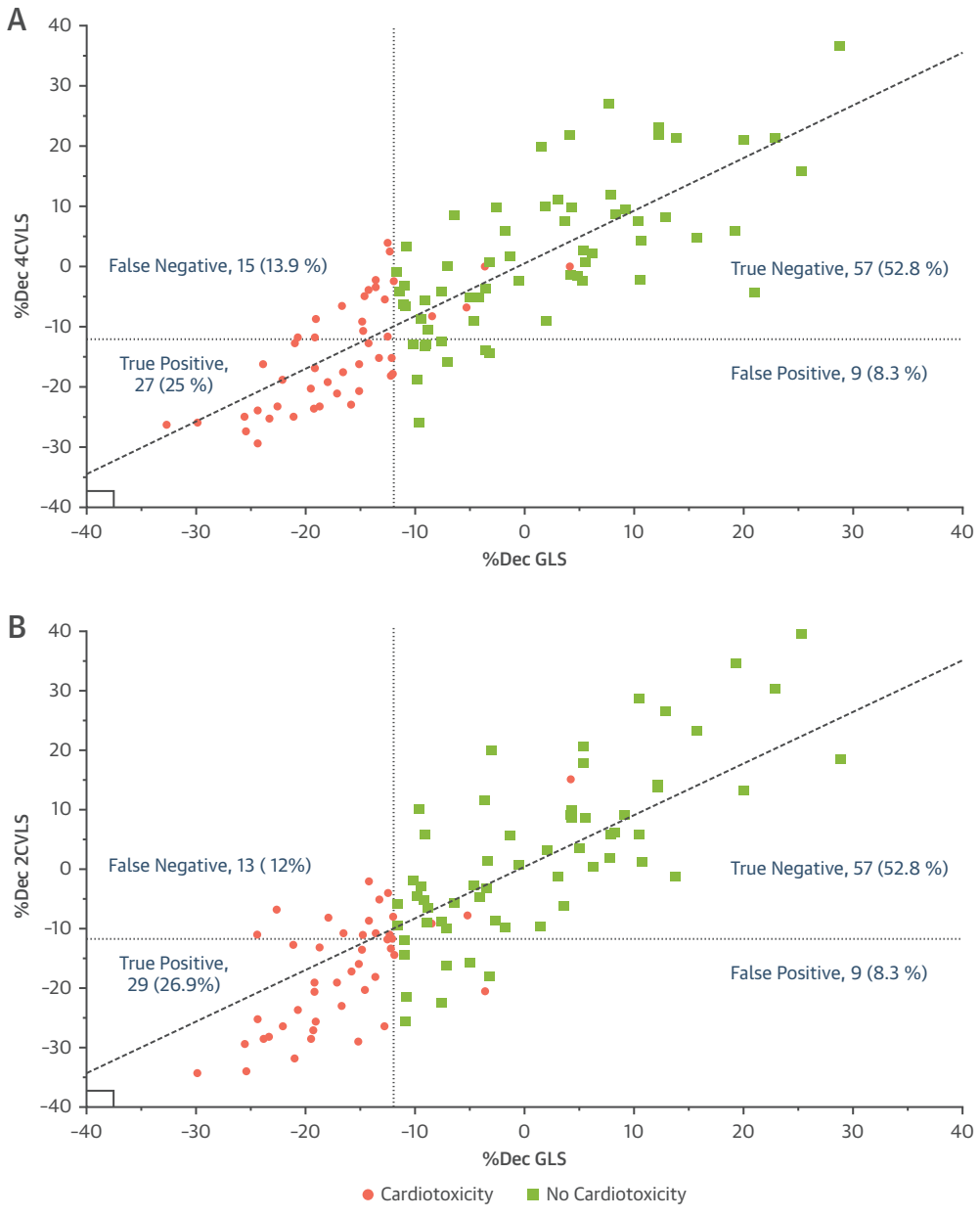


The **top 2 panels** demonstrate linear regression curves comparing baseline **(left panel)** GLS versus the 2-chamber view longitudinal (2CV_LS) strain and follow-up **(right panel)** GLS versus follow-up 2CV_LS. The **bottom 2 panels** are the respective Bland-Altman plots. Abbreviations as in Figure 1.

decrease >0.10 from baseline to <0.53 or a relative GLS decrease of >15%) (7), 28 patients developed cardiotoxicity. Comparing a >15% relative change in 4CV_LS versus GLS yielded 5 (5%) false-negative findings and 7 (6%) false-positive findings, resulting in a discordance rate of 11% and a diagnostic accuracy of 89% (Figure 2). Comparing a >15% relative change in 2CV_LS versus GLS yielded 6 (6%) false-negative findings and 10 (9%) false-positive findings, resulting in a discordance rate of 15% (Figure 2) and a diagnostic accuracy of 85%.

The third criterion involved using only a relative GLS reduction of ≥12% without the LVEF criterion or >15% without the LVEF criterion; 42 and 26 patients, respectively, met these criteria for cardiotoxicity (Figures 3 and 4). Agreement for detection of cardiotoxicity using a relative change in GLS ≥12%, and the same change with 4CV_LS and 2CV_LS as determined by the kappa statistic, was 0.52 (95% confidence interval [CI]: 0.35 to 0.69) and 0.56 (95% CI: 0.40 to 0.73). Similarly, for the >15% threshold it was 0.70 (95% CI: 0.55 to 0.86) and 0.62 (95% CI: 0.45 to 0.79). Using receiver-operating curve analysis, we examined the threshold relative changes in single-chamber LS values that would have the best balance of sensitivity and specificity to detect cardiotoxicity using the GLS thresholds of 12% and 15%. A 4CV_LS change of 10.7% (AUC: 0.88; 95% CI: 0.80 to 0.93; sensitivity of 74%; specificity of 86%) and a 2CV_LS change of 10.9% (AUC: 0.90; 95% CI: 0.83 to 0.95; sensitivity of 83%; specificity of 86%) had the best discrimination for a GLS change ≥12%. Similarly, a 4CV_LS change of 16.3% (AUC: 0.95; 95% CI: 0.89 to 0.98; sensitivity of 81%; specificity of 95%) and a

FIGURE 3 Comparison of Differences Between Measurements of GLS and LS

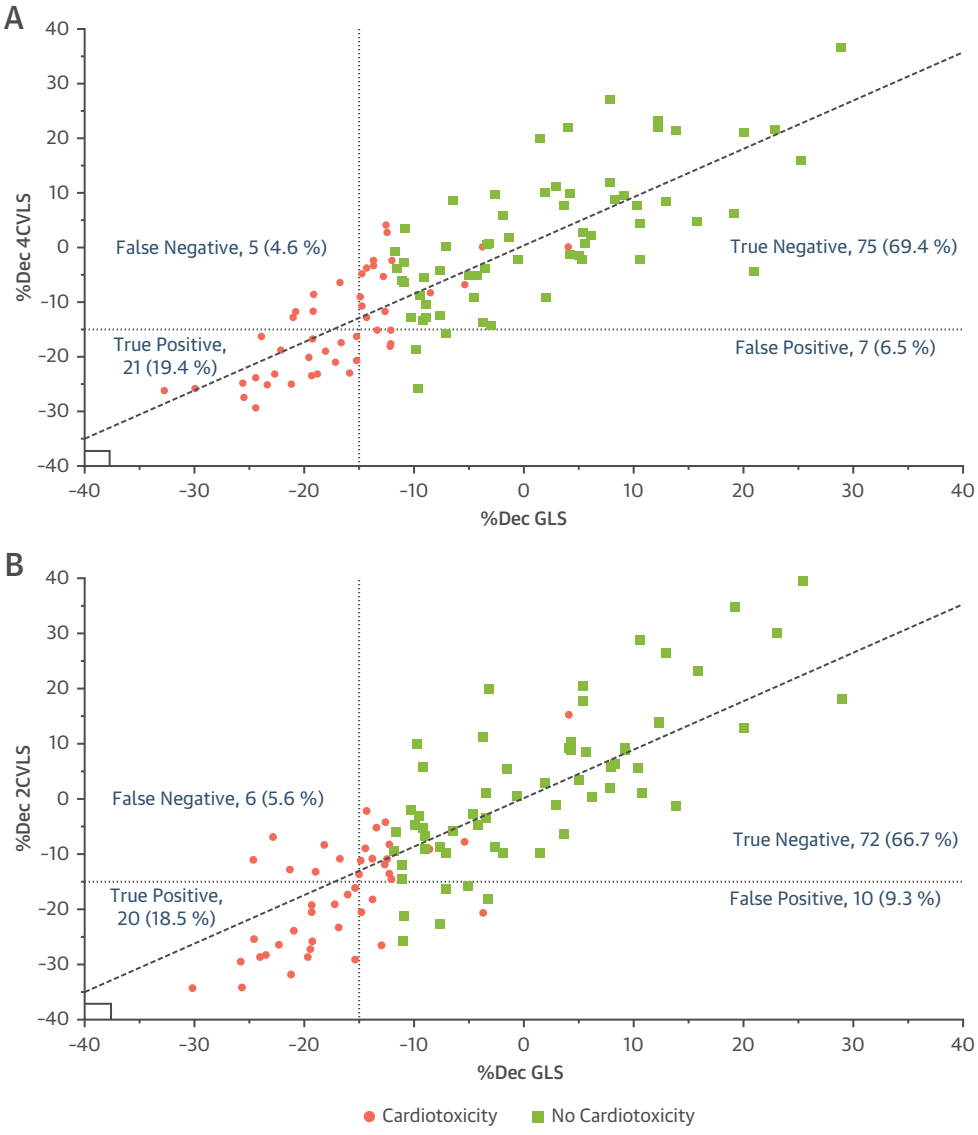


(A) Single-view LS measurement using 4CV_LS and **(B)** 2CV_LS. Cardiotoxicity is defined based on a drop in strain ≥12% or reduction in left ventricular ejection fraction by >0.10 to <0.55. Abbreviations as in Figures 1 and 2.

2CV_LS change of 11.0% (AUC: 0.92; 95% CI: 0.86 to 0.97; sensitivity of 92%; specificity of 77%) had the best discrimination for a relative GLS change >15%. There was no statistically significant difference in the AUC for the 4CV_LS and 2CV_LS to discriminate cardiotoxicity based on GLS threshold of ≥12% and >15% (Figure 5).

REPRODUCIBILITY. Interobserver and intraobserver reproducibility for GLS, 4CV_LS, and 2CV_LS assessed by using intraclass correlation and coefficients of variation are summarized in Table 2. GLS measurements had better interobserver and intraobserver reproducibility than individual-view based LS measurements.

FIGURE 4 Comparison of Strain Changes Between Measurements of GLS and LS

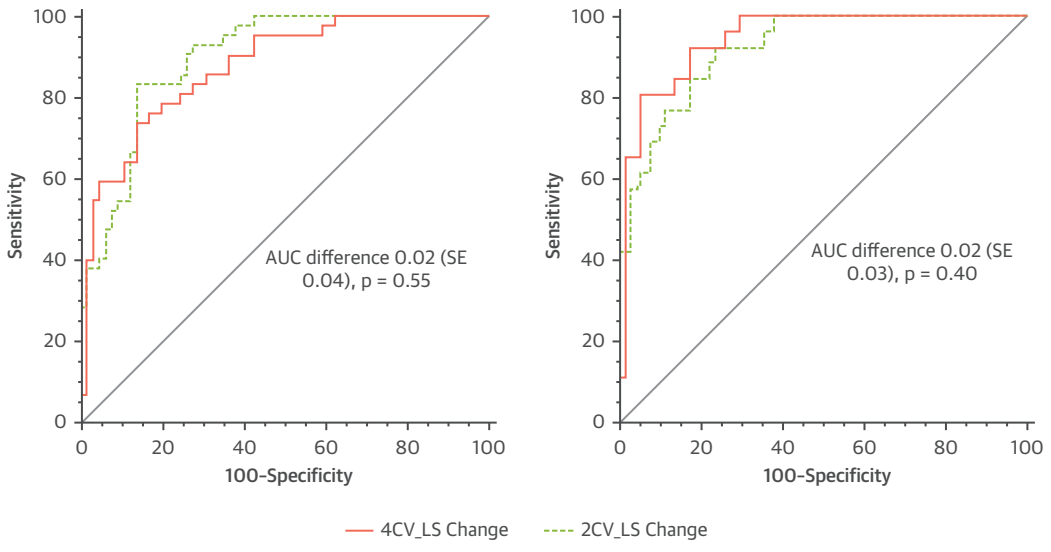


(A) Single-view LS measurement using 4CV_LS and **(B)** 2CV_LS. Cardiotoxicity is defined based on a relative fall in strain >15% or a reduction in left ventricular ejection fraction by >0.10 to <0.53. Abbreviations as in Figures 1 and 2.

DISCUSSION

The development of a new measurement warrants consideration of 3 relevant parameters: concordance with existing measures, reproducibility, and accuracy. In patients receiving cancer therapy for breast or hematological malignancies, this study showed that measurement of LS using a single 4- or 2-chamber view has good correlation, minimal bias, and modest level of agreement with GLS measurements obtained from the average of 3 long-axis views. However, for the detection of cardiotoxicity, the use of the 4CV_LS or 2CV_LS alone resulted in discordance of 11% to 22% depending on the definition used. When defining cardiotoxicity based on a relative drop in GLS alone, the agreement between 4CV_LS or 2CV_LS and GLS was modest, with kappa values ranging from 0.52 to 0.70. Moreover, the reproducibility of strain measurements was superior for GLS compared with the single-view LS measurements.

FIGURE 5 Comparison of 4CV_LS and 2CV_LS Measurements to Discriminate a GLS Reduction



Panels show a relative GLS drop of ≥12% **(left)** and >15% **(right),** respectively. There were no statistically significant differences between the 2 methods for both definitions. AUC = area under the curve.

GLS AND CARDIOTOXICITY DETECTION. A threshold change in LVEF during cancer therapy has been the most common method used to identify the onset of cardiotoxicity. However, several studies, especially with anthracycline treatment, have shown that once LVEF drops, complete recovery occurs in <25% of the patients despite appropriate heart failure therapy (10). Patients with incomplete recovery are at a higher risk of developing subsequent adverse cardiac events (5,10). Therefore, there has been ongoing interest in early markers of myocardial dysfunction. Echocardiographic GLS has consistently emerged as an imaging technique that identifies subclinical myocardial dysfunction during cancer therapy (1). A >10% to 15% fall, relative to baseline GLS, seems to predict a subsequent significant reduction in LVEF or development of congestive heart failure. Therefore, GLS measurement provides an opportunity to initiate cardioprotective treatments (e.g., beta-blockers) to prevent reduction in LVEF or development of congestive heart failure (11). This approach is the focus of ongoing studies such as the SUCCOUR randomized controlled trial. Subsequent studies may also compare an absolute change versus relative change in GLS; currently, there is no evidence to show that one is superior to the other.

TABLE 2 Interobserver and Intraobserver Variability of Strain Measurements

	Intraobserver		Interobserver	
	ICC	COV	ICC	COV
GLS	0.95 (0.88–0.98)	2.9 (2.1–3.8)	0.93 (0.82–0.97)	3.7 (2.7–4.7)
4CV_LS	0.91 (0.77–0.96)	4.1 (2.8–5.4)	0.85 (0.62–0.94)	4.4 (2.9–6.0)
2CV_LS	0.88 (0.71–0.95)	4.2 (2.0–6.4)	0.87 (0.68–0.95)	4.8 (3.0–6.6)

GLS = global longitudinal strain measured using 3 apical long-axis views; COV = coefficient of variance; ICC = intraclass correlation; 2CV_LS = 2 chamber view longitudinal strain; 4CV_LS = 4-chamber view longitudinal strain.

GLOBAL VERSUS SINGLE-PLANE STRAIN. Given the promising diagnostic and prognostic data with GLS, there has been interest in promoting the uptake of GLS measurements in routine echocardiography. This approach has included standardization of strain measurements between vendors, automated contour detection, and user-friendly strain quantification algorithms. GLS is a reproducible parameter with a relatively short learning curve (8), and its automation might enable access to this measurement at point of care (6). The latter step might improve the workflow for strain imaging in busy echocardiography laboratories, especially in the context of repeated clinic visits.

Further improvement in the speed and feasibility of strain measurements in cardio-oncology and the potential to use strain at point of care may be achieved using a single-view LS as an alternative to GLS. However, despite good correlation and agreement between GLS and single-view LS, there were disagreements in the recognition of threshold

changes in strain used to define cardiotoxicity, with generally more false-negative findings with the single-view LS. The disagreement was lower when using higher strain cutoff values. However, the agreements were still modest at best (kappa of 0.7). In addition, there was no difference in the discriminatory value of 4CV_LS and 2CV_LS for GLS-based definitions of cardiotoxicity. Our findings therefore suggest that GLS and single-view LS measurements are not interchangeable. Different threshold changes in single-view LS can be used to define cardiotoxicity; however, whether these changes have the same prognostic value needs to be defined prospectively.

The existing published data supports the prognostic value of GLS (1), and this measurement should remain the primary method to monitor for cardiotoxicity. This approach is further supported by the fact that GLS measurements had better interobserver and intraobserver variability than individual-view LS measurements. The latter is likely a reflection of the fact that GLS is measured as an average of multiple views and multiple segments, hence reducing overall variability.

IMPROVING WORKFLOW FOR GLS MEASUREMENTS. Given that GLS measurements remain the method of choice to manage patients during cancer therapy, several workflow methods can improve the efficiency of strain measurements in an echocardiography laboratory. First, standard protocols should be implemented for strain measurements. It is helpful to identify a small group of sonographers who are dedicated to performing strain measurements. This group should first become familiar with a single vendor for a prolonged period of time before learning other vendors. This approach provides an opportunity to gain focused expertise in the acquisition, post-processing, and interpretation of the images and to increase the comfort level and speed of measurements. These sonographers could also learn to recognize patients in whom strain measurements would not be useful, as in cases of poor image quality, significant arrhythmia, or foreshortened images. Other sonographers can be educated on the techniques to improve strain acquisition and analysis (12). There should also be a move toward using automated methods for endocardial contouring for strain measurements. Collaboration between vendors is necessary to ensure that strain tracking adequacy can be visualized on all reporting systems for the reporting physician to verify the accuracy of the strain values. In addition, methods to automatically include previous strain values in the report with calculation of relative changes will enhance the utility of GLS in clinical practice.

STUDY LIMITATIONS. Because we do not have an external reference standard, we were only able to compare agreement between GLS and single-chamber LS measurements as opposed to accuracy relative to EF change, for example. However, changes in GLS based on 3 apical views have been shown to have prognostic value in multiple studies of patients receiving cancer therapy, whereas there are currently no prognostic data with single-chamber LS measurements. Therefore, comparing single-chamber LS versus GLS provides a fair comparison of agreement. We were also unable to compare the predictive ability of GLS versus single-view LS for the subsequent reduction in LVEF or congestive heart failure; this information will become available when patients have completed the ongoing trial. We used 2-dimensional LVEF instead of 3-dimensional LVEF as part of the definition of cardiotoxicity to be consistent with the existing published data that has shown the prognostic value of GLS in cardio-oncology. Also, the focus of this study was not on the recognition of cardiotoxicity based on LVEF but rather based on GLS. Our sensitivity analysis excluding LVEF measurements did not reveal any differences in our conclusions.

Although we included patients with breast and hematological malignancies in our study, the common factor in all these patients was the fact that they received anthracycline-based therapy and were deemed to be at elevated risk for cardiotoxicity.

CONCLUSIONS

Our findings show that GLS measured using 3 apical long-axis views has good correlation with LS measured from apical 4- or 2-chamber views alone. However, for the definition of cardiotoxicity based on strain values, these measurements are not interchangeable, with discordance ranging from 11% to 22%. Standard (3 view based) GLS is more reproducible than single-view LS measurements. Therefore, GLS from multiple apical views should remain the preferred method to manage patients during cancer therapy to detect cardiotoxicity.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Although the use of a single-view apical 4- or 2-chamber echocardiography image–based LS measurement could improve workflow in echocardiography laboratories, it was founded to have a 15% to 22% discrepancy compared with GLS for the detection of cardiotoxicity. Measurements of GLS had better interobserver and intraobserver variability than single-view LS measurements.

TRANSLATIONAL OUTLOOK: Echocardiography-measured GLS should remain the method of choice for early detection of cardiotoxicity. Protocols to improve the rapidity and reliability of GLS measurements should be implemented in echocardiography laboratories.

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APPENDIX For a list of the SUCCOUR investigators, please see the online version of this paper.