## International Journal of Clinical Cardiology

*BRIEF REPORT*

# Utility of Global Longitudinal Strain to Predict Post-Operative Outcomes in Non-Cardiac Surgeries

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### Abstract

**Background:** Pre-operative echocardiography is performed in select groups of patients for cardiac risk stratification. Many parameters, including Left Ventricular Ejection Fraction (LVEF), are assessed during echocardiography. While many studies have cited association between low LVEF and poor operative outcomes, patients with preserved LVEF might have subtle LV dysfunction that may result in adverse outcome. Studies have described the routine use of global longitudinal strain (GLS) as an alternative measure of ventricular function that can detect subtle LV dysfunction. The aim of this study is to determine the value of GLS in predicting post-operative outcomes in non-cardiac surgeries.

**Methods:** This was a retrospective study of patients who had normal LVEF, had undergone subsequent non-cardiac surgery, and had post-operative troponins measured. Outcomes for post-operative myocardial injury, as well as hospital re-admissions and mortality up to 1-year post-surgery were collected. Post-op myocardial injury was defined as a peak Troponin T value of > 0.030 ng/dL or a > 20% increment from baseline.

**Results:** A total of 42 patients were included. 61.9% (n = 26) were males and mean age was 72.3 years. Mortality at 1 year was 14.3% (n = 6) and 28.6% (n = 12) were deemed to have post-operative myocardial injury. 1-year mortality was associated with lower GLS (-18.95% vs. -23.75%, p = 0.001). However, GLS was not associated with post-operative myocardial injury and hospital readmissions.

**Conclusion:** Although GLS values were decreased in non-survivors, our study did not demonstrate the utility of GLS in predicting post-operative events.

## Introduction

Post-operative adverse events in non-cardiac surgery are an important cause of morbidity and mortality. Pre-operative assessment aims to evaluate such risks so that measures can be implemented to prepare higher risk patients for surgery. Transthoracic echocardiography is a safe, non-invasive and reproducible technique and its use is becoming increasingly popular in the pre-operative assessment of patients with, or who are at risk of cardiovascular disease. Guidelines include indications for resting echocardiography in selected patients, for example those with heart failure or valvular heart disease [1,2]. However, even unselected patients have been shown to have a substantial risk of perioperative cardiac events [3,4], and resting echocardiography could have a role in the identification of these patients.

During echocardiography, many parameters, including Left Ventricular Ejection Fraction (LVEF), are assessed. While studies have cited association between low LVEF and poor operative outcomes such as mortality and perioperative myocardial infarction [5], the usage of LVEF assessment has limitations as patients with preserved LVEF could have subtle or subclinical left ventricular (LV) dysfunction. Studies have described the routine use of global longitudinal strain (GLS) as an alternative measure of ventricular function, with GLS having been reported to be a reliable marker in detecting subclinical LV dysfunction [6,7]. Other than the

Park et al. Int J Clin Cardiol 2021, 8:217

• Page 1 of 5 •

potential to improve cardiovascular risk stratification in subjects with normal LVEF, GLS has also shown good reproducibility [8]. This adds incremental value in predicting myocardial function and in risk stratification. In fact, several studies have documented GLS being a useful preoperative parameter in predicting postoperative LV dysfunction and adverse events after cardiac valve surgery.

The aim of our study is to determine the value of GLS in predicting post-procedural outcomes in patients with normal LVEF undergoing non-cardiac surgeries.

## Methods

This was a retrospective study of all patients who had echocardiography performed for a pre-operative indication from February 2017 to October 2017. These patients were screened for those who had normal LVEF, had undergone subsequent non-cardiac surgery, and had post-operative troponins measured. Medical records were traced for baseline demographics, past medical history and echocardiographic parameters (including measures of diastology such as E/A ratio, E/e', indexed left atrium size and maximal tricuspid regurgitation velocity). GLS evaluation of pre-operative echocardiographic data was performed using TOMTEC-ARENA TTA2 (TOMTEC Imaging Systems GmbH) by assessors blinded to patient outcomes. Outcomes for post-operative myocardial injury, as well as hospital re-admissions and mortality up to 1 year post-surgery were collected. Post-op myocardial injury was defined as a peak Troponin T value of > 0.030 ng/dL (which is above the 99th percentile upper reference limit for our laboratory) and/or a troponin level with > 20% increment from baseline within the same admission [9]. Statistical analysis was performed using IBM SPSS Statistics 19.0 (IBM Corp, Armonk, NY, USA). Data was expressed as mean ± standard deviation for continuous variables, and percentages or numbers for categorical variables. Categorical and dichotomous variables were compared using chi-square test or Fisher's exact test (in cases where number of observations were less than five). Continuous variables were compared with *t*-test.

Ethics approval for this project was obtained from the local Centralised Institutional Review Board.

## Results

A total of 42 patients were included. 61.9% (n = 26) were males and mean age was 72.3 years. A significant number of them had comorbidities including diabetes, ischaemic heart disease and chronic kidney disease (Table 1). Orthopaedic surgery was found to be the commonest type of surgery performed (Table 2).

Mortality at 1 year was 14.3% (n = 6) and 28.6% (n = 12) were deemed to have post-operative myocardial injury. 1-year mortality was associated with a lower GLS (-18.95% ± 1.57% vs. -23.75% ± 3.21%, p = 0.001). However, GLS was not associated with other post-ope-

**Table 1:** Prevalence of comorbidities, n (%).

| Diabetes | 23 (54.8%) |
|---|---|
| Hyperlipidemia | 30 (71.4%) |
| Hypertension | 34 (81.0%) |
| Atrial fibrillation | 6 (14.3%) |
| History of congestive cardiac failure | 5 (11.9%) |
| History of ischaemic heart disease | 12 (28.6%) |
| Chronic kidney disease | 12 (28.6%) |
| History of stroke/transient ischemic attack | 7 (16.7%) |
| Active cancer | 11 (26.2%) |

**Table 2:** Types of procedures, n (%).

| General | 4 (9.5%) |
|---|---|
| Colorectal | 2 (4.8%) |
| Hepatobiliary | 6 (14.3%) |
| Vascular | 6 (14.3%) |
| Urology | 4 (9.5%) |
| Orthopaedics | 15 (35.7%) |
| Endoscopy | 5 (11.9%) |

rative events such as post-operative myocardial injury and hospital readmissions. In our study population, only a history of ischemic heart disease predicted post-operative myocardial injury (58.3% vs. 16.7%, p = 0.019) (Table 3).

Other demographic or echocardiographic factors were also not associated with significant differences in outcomes except a history of active cancer that was associated with 1-year mortality (66.7% vs. 19.4%, p = 0.032). There was, however, no significant difference in GLS between those with and without active cancer (-22.35 ± 3.43 vs. -23.31 ± 3.49, p = 0.435).

## Discussion

Global longitudinal strain is an echocardiographic marker that can be useful in the pre-operative evaluation of patients undergoing surgery. While multiple studies have provided support with regards to the additional prognostic value that GLS adds in preoperative management, majority were in populations undergoing cardiac surgeries [10-12]. Our study aimed to evaluate the utility of GLS in the assessment of patients with normal LVEF undergoing non-cardiac surgeries.

Our study population had a relatively high rate of post-operative myocardial injury. This could be attributed to our study population having multiple cardiovascular risk factors. More than half of them had either diabetes, hyperlipidemia, or hypertension and more than a quarter had a history of ischemic heart disease. Unsurprisingly, a statistically significant association between a history of ischaemic heart disease and post-operative myocardial injury was found. Although GLS was not associated with post-operative myocardial injury, our result could have been limited by our small sample size.

**Table 3:** Demographic and echocardiographic predictors of outcomes.

| Variable | 1-year mortality | | | Post-op myocardial injury | | | Hospital readmissions | | |
|---|---|---|---|---|---|---|---|---|---|
| | No.(%)/mean ± SD | | | | | | | | |
| | Died (n = 6) | Survived (n = 36) | p-value | MI (n = 12) | No MI (n = 30) | p-value | Readmitted (n = 21) | Event free (n = 21) | p-value |
| Male gender | 5 (83.3) | 21 (58.3) | 0.380 | 8 (66.7) | 18 (60.0) | 0.740 | 12 (57.1) | 14 (66.7) | 0.525 |
| Age (yr) | 79.7 ± 10.9 | 71.1 ± 12.9 | 0.131 | 75.4 ± 12.6 | 71.0 ± 12.9 | 0.325 | 72.4 ± 11.6 | 72.2 ± 14.3 | 0.962 |
| Creatinine (µmol/L) | 84.7 ± 72.4 | 164.9 ± 196.6 | 0.333 | 157.4 ± 155.6 | 151.8 ± 198.8 | 0.931 | 156.2 ± 232.4 | 150.6 ± 128.8 | 0.923 |
| Diabetes | 3 (50.0) | 20 (55.6) | 1.000 | 6 (50.0) | 17 (56.7) | 0.695 | 12 (57.1) | 11 (52.4) | 0.757 |
| Hyperlipidemia | 5 (83.3) | 25 (69.4) | 0.655 | 8 (66.7) | 22 (73.3) | 0.715 | 15 (71.4) | 15 (71.4) | 1.000 |
| Hypertension | 5 (83.3) | 29 (80.6) | 1.000 | 11 (91.7) | 23 (76.7) | 0.402 | 16 (76.2) | 18 (85.7) | 0.697 |
| Atrial fibrillation | 1 (16.7) | 5 (13.9) | 1.000 | 3 (25.0) | 3 (10.0) | 0.329 | 4 (19.0) | 2 (9.5) | 0.663 |
| CCF | 0 (0.0) | 5 (13.9) | 1.000 | 3 (25.0) | 2 (6.7) | 0.131 | 2 (9.5) | 3 (14.3) | 1.000 |
| IHD | 2 (33.3) | 10 (27.8) | 1.000 | 7 (58.3) | 5 (16.7) | 0.019* | 8 (38.1) | 4 (19.0) | 0.172 |
| CVA/TIA | 1 (16.7) | 6 (16.7) | 1.000 | 3 (25.0) | 4 (13.3) | 0.387 | 2 (9.5) | 5 (23.8) | 0.410 |
| Active cancer | 4 (66.7) | 7 (19.4) | 0.032* | 2 (16.7) | 9 (30.0) | 0.464 | 8 (38.1) | 3 (14.3) | 0.079 |
| GLS (%) | -18.95 ± 1.57 | -23.75 ± 3.21 | 0.001* | -23.45 ± 2.79 | -22.91 ± 3.72 | 0.653 | -23.37 ± 2.92 | -22.76 ± 3.97 | 0.571 |
| E/A ratio | 0.74 ± 0.26 | 0.93 ± 0.28 | 0.178 | 0.84 ± 0.27 | 0.92 ± 0.29 | 0.480 | 0.94 ± 0.26 | 0.87 ± 0.31 | 0.467 |
| E/e' | 9.6 ± 2.6 | 13.2 ± 6.7 | 0.213 | 12.4 ± 6.8 | 12.7 ± 6.2 | 0.924 | 13.9 ± 6.6 | 11.1 ± 5.7 | 0.174 |
| LA size indexed (ml/m²) | 35.9 ± 11.4 | 31.2 ± 9.3 | 0.419 | 29.9 ± 8.8 | 32.3 ± 9.8 | 0.523 | 32.3 ± 10.5 | 30.8 ± 8.3 | 0.656 |
| TR Vmax (m/s) | 2.30 ± 0.54 | 2.46 ± 0.63 | 0.630 | 2.58 ± 0.82 | 2.39 ± 0.50 | 0.382 | 2.40 ± 0.69 | 2.50 ± 0.51 | 0.641 |

*p < 0.05 is considered statistically significant.

CCF: Congestive Cardiac Failure; CVA: Cerebrovascular Accident; IHD: Ischaemic Heart Disease; LA: Left Atrium; MI: Myocardial Injury; TIA: Transient Ischaemic Attack; TR Vmax: Maximal Tricuspid Regurgitation Velocity

It is also worth noting that our study showed lower GLS having an association with increased 1-year mortality. A study by Dahl, et al. showed that there was an association between lower GLS values and cardiac mortality in patients undergoing aortic valve replacement [13], raising the possibility that GLS has prognostic value involving a mechanism where myocardial structure is affected and thus contributing to a worsening cardiac function thereafter. This is further demonstrated by Wiedemann, et al. where an association between myocardial fibrosis and low GLS suggested that the structure of the heart that gives rise to its function may be affected in severe aortic stenosis [14]. In our study population, we postulate that lower GLS are a reflection of underlying myocardial structural changes and subclinical dysfunction that lead to increased mortality.

Our study had a number of limitations. The first is our small sample size as mentioned above, limiting our study's ability to detect differences. Indeed, GLS was not shown to predict other outcomes such as myocardial injury and hospital readmissions. Furthermore, traditional cardiac risk factors [4], such as congestive cardiac failure and cerebrovascular disease, were numerically different when comparing the rates of post-operative myocardial injury but were not shown to be statistically significant in our study. Secondly, there was a wide spectrum of various surgeries being performed under differing anaesthetic methods. There are differences of each; where emergency surgeries tend to have higher mortality compared to elective ones [15,16] and general anaesthesia being associated with more post-operative complications and cardiac events [17,18]. Presence of such differences can have a significant impact in determining outcomes but these were not specifically looked at in our study. Lastly, our sample selection could have been biased as the selected patients who had troponins performed could have been sicker to begin with or had other clinical indications for the cardiac troponins to be measured, and this could have contributed to the relatively high post-operative rates of myocardial injury.

In conclusion, GLS is an echocardiographic parameter that has potential for use in the pre-operative setting due to its ability to detect subclinical LV dysfunction. Current literature suggests its usefulness as a prognostic marker for post-operative events in patients undergoing cardiac surgeries. Although our small study sample did not demonstrate the utility of GLS in predicting post-operative events, GLS values were lower in non-survivors and further study should be done to evaluate the utility of GLS in the pre-operative setting.

## Authors Declaration

No potential conflict of interest relevant to this article was reported.

IRB: 2018/3003 (Singapore Health Services Centralised Institutional Review Board)

Clinical trial registration number: Not applicable.

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Park et al. Int J Clin Cardiol 2021, 8:217

• Page 4 of 5 •

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