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Evaluation of Global Longitudinal Strain Pattern (GLS) and Echocardiographic Parameters in the Sleeve Gastrectomy Patients Before and After Surgery

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ABSTRACT

Background & Objective: Obesity is one of the problems associated with cardiovascular complications. Patients' heart function improves after sleeve gastrectomy. Global Longitudinal Strain (GLS) is one of the methods used to monitor heart function before and after sleeve gastrectomy. In this study, we evaluated the echocardiographic parameters pre and post sleeve gastrectomy.

Materials & Methods: In this cross-sectional study, 22 patients including 17 female and 5 maleundergoing sleeve gastrectomy were studied. They had referred to Shariati Hospital in Tehran during 2019 – 2020. All patients underwent 2D echocardiography using speckle-tracking to evaluate left ventricular function and measure GLS.

Results: Data analysis showed that GLS increased after surgery compared to preoperative period (15.4 ± 3.8 vs. 18.4 ± 3.04). Also, PAP, LVEDV, LVESV, LVDD, LVDS and AO were higher in the mentioned period; these findings were statistically significant (p-value <0.05). However, the RVSM mean, TAPSE, RVFAC and LVH parameters were higher post-surgery in comparison to the pre- surgery; a significant relationship was observed between the parameters before and after surgery.

Conclusion: It can be concluded that GLS method, which evaluates echocardiographic parameters in obese patients undergoing sleeve gastrectomy can be highly significant in monitoring patients.

Keywords: Sleeve Gastrectomy, Echocardiography, Surgery, Global Longitudinal Strain Pattern

Introduction

Obesity is a social problem with an increasing prevalence (1). It can cause problems for many patients, and in some cases endanger their health (2). On the other hand, it can cause cardiovascular diseases, endothelial cell dysfunction and elevated blood pressure (3). So far, many drugs and strategies have been proposed to reduce weight and improve obesity in patients, but none of them is completely effective.

On the other hand, it has been found that lifestyle changes can hardly lead to weight loss. Recently, metabolic surgeries such as sleeve gastrectomy are widely used (4, 5). Strain in the heart, which is expressed as changes in the length of myocardial fibers in the longitudinal or transverse direction, is one of the screening methods to assess systolic and diastolic function; it is performed using echocardiography (6). GLS is used as a diagnostic method for systolic and diastolic disorders (7, 8).

Given that obesity is one of the risk factors for systolic and diastolic pressure disorders, and since sleeve gastrectomy has been shown to improve these disorders, we decided to evaluate GLS pre and post sleeve gastrectomy, for the first time.

Materials and Methods

This cross-sectional study evaluated the patients undergoing sleeve gastrectomy; the patients had referred to Shariati Hospital of Tehran city, during 2019 – 2020. Only patients with Left ventricular ejection fraction (LVEF) over 50% were included, and patients

with left ventricular dysfunction with reduced LVEF were also excluded from the study.

Exclusion criteria included the presence of cardiomyopathies, previous amyloidosis, moderate to severe valvular disease, evidence of coronary heart disease, clinical, laboratory or echocardiographic evidence of heart failure, congenital heart disease, diabetes and kidney failure. Demographic information including gender, age, history of underlying diseases, status of cardiovascular disease risk factors, weight and height, Body Mass Index (BMI) and electrocardiography results, as well as medical records were collected through interviews or review of the clinical records.

All patients underwent 2D echocardiography using speckle-tracking to evaluate left ventricular function and measure GLS. Echocardiography examinations were all performed by a cardiologist. Images were digitized at least three consecutive beats, and analyzed off-line using proprietary software by an operator. Longitudinal strain was measured for all subjects in three standard apical views (2- chamber, 4- chamber and 3 -chamber) in two continuous resting cardiac cycles, separately; it was also used to calculate GLS. Patients were then followed up for nine months and again underwent echocardiography and BMI assessment.

Statistical Analysis

The statistical analysis results for quantitative variables were expressed as mean and standard deviation (mean ± SD), and as percentage for stratified qualitative variables. The t test or ANOVA was used to compare quantitative variables, and the chi-square test was performed to compare qualitative variables. The significance level was considered as <0.05. Statistical analysis was performed by SPSS software version 23.

Results

In the present study, 17 (77.3%) cases were female and 5 (22.7) were male. The aim was to evaluate echocardiographic and GLS parameters in patients, who had undergone sleeve gastrectomy. The results showed reduced postoperative BMI compared to the preoperative value, indicating a statistically significant difference. The means of Ejection Fraction (EF) before and after surgery were 55.8 ± 6.4 and 62.8 ± 4.4, respectively; the difference was statistically significant.

Means of apical 2, 3 and 4 chamber (A2, 3,4 CH) GLS were higher in post-surgical period, compared to the pre-surgical period; they were also statistically significant. There was also a significant difference in Left ventricular hypertrophy (LVH) and RV GLS before and after surgery (p-value <0.05). The mean of pulmonary artery pressure (PAP), Left Ventricular end-diastolic volume(LVEDV), LV end-systolic volume (LVESV), left ventricular diastolic dimension (LVDD) and LV systole dimension (LVDS) were higher preoperation (p-value <0.05). However, the means of Right ventricular systolic velocity (RVSM), Tricuspid annular plane systolic excursion (TAPSE), RV fractional area change (RVFAC) and LVH parameters were higher after surgery; a significant relationship was also observed between them (Table 1).

Table1. Echocardiography result of patients before and after operation.

Variables	Pre-operation	Post-operation	P-value
BMI	45.0 ± 5.3	33.3 ± 4.3	0.0
EF	55.8 ± 6.4	62.8 ± 4.4	0.0
PAP	26.6 ± 4.4	23.4 ± 4.5	0.001
TAPSE	22.9 ± 3.03	24.1 ± 2.8	0.04
LVEDV	106.8 ± 34. 6	89.5 ± 19.2	0.001
LVESV	49.1 ± 21.3	32.7 ± 7.8	0.0
LVDD	48.1 ± 4.4	46.6 ± 4.1	0.004
LVDS	27.7 ± 4.4	24.9 ± 3.4	0.0
RVFAC	0.39 ± 0.07	0.52 ± 0.07	0.0
AO	29.2 ± 4.2	28.5 ± 4.1	0.29
LVH	2.6 ± 0.78	1.7 ± 0.88	0.002

Variables	Pre-operation	Post-operation	P-value
IVSD	10.2 ± 1.9	8.7 ± 1.3	0.001
PW	9.8 ± 1.5	8.04 ± 1.04	0.0
DD	1.6 ± 0.49	1.1 ± 0.35	0.001
E velocity	9.5 ± 1.9	7.3 ± 2.0	0.0
A_3CH GLS	14.4 ± 4.6	17.9 ± 3.6	0.00
A_2CH GLS	16.1 ± 4.5	18.6 ± 3.4	0.002
A_4CH GLS	16.7 ± 4.1	18.8 ± 3.5	0.007
Mean GLS	15.4 ± 3.8	18.4 ± 3.04	0.0
RV GLS	10.9 ± 5.9	14.2 ± 4.3	0.0
RVD	28.4 ± 2.7	27.7 ± 2.7	0.07

Abbreviations: BMI: Body Mass Index; EF: Ejection Fraction; PAP: Pulmonary Artery Pressure; RVSM: Right Ventricular Systolic Velocity; TAPSE: Tricuspid Annular Plane Systolic Excursion; LVEDV: Left Ventricular end-diastolic volume; LVESV: LV End-Systolic Volume; LVDD: Left Ventricular Diastolic Dimension; LVDS: LV Dimension During Systole; RVFAC: RV Fractional Area Change; AO: Aortic Root; LVH: *Left Ventricular Hypertrophy*; IVSD: Interventricular Septal Diastolic Diameter; PW: Posterior Wall; DD: Diastolic Dysfunction; RVD: Right Ventricular Diastolic Diameter; RV GLS: Right Ventricular Global Longitudinal Strain.

Evaluation of the BMI and echocardiography parameters:

In this study, patients were divided into three groups based on their BMIs. Individuals with BMI of 40-45 were categorized in group I (n=10), 46-50 in group II (n=8), and >50 in group III (n=4). Then echocardiographic parameters in these three groups were compared before and after surgery. For this purpose, it was found that the difference between the mean LVEDV and LVESV was statistically significant in the first two groups compared to the second group. The mean postoperative RVFAC parameter increased compared to the preoperative period in the second group, which was also statistically significant.

Also, significant relationships were observed between the means of E velocity, pulse wave (PW) and the GLS parameters before and after surgery in the first and second groups. However, in terms of AO parameter no significant relationship was observed between the three groups in the pre and post-surgical periods (Table 2).

Table2. Association between BMI and Echocardiography parameters.

Variables	operation		P-Value *
	pre	**Post**	
LVEDV	106.7 ± 32.39	91.1 ± 16.7	0.05 *
	100.6 ± 31.18	88.1 ± 20.69	0.01 **
	109.06 ± 57.68	81.6 ± 28.02	0.25 ***
LVESV	46.1 ± 19.1	31.9 ± 6.8	0.02 *
	45.1 ± 17.4	33.03 ± 6.9	0.01 **
	59.5 ± 34.2	28.5 ± 8.8	0.17 ***
RVFAC	0.54 ± 0.04	0.39 ± 0.04	0.0 *
	0.37 ± 0.09	0.50 ± 0.11	0.01 **
	0.44 ± 0.08	0.53 ± 0.05	0.16 ***
E velocity	7.8 ± 2.1	9.7 ± 2.3	0.02 *
	7.2 ± 1.8	9.3 ± 1.5	0.0 **

Variables	operation		P-Value *
	pre	Post	
	6.5 ± 2.5	10.1 ± 1.6	0.23 ***
A3CH GLS	15.07 ± 7.3	17.8 ± 4.1	0.0 *
	15.7 ± 3.6	18.8 ± 3.2	0.01 **
	10.2 ± 2.8	15.6 ± 3.4	0.14 ***
A٢CH GLS	20.5 ± 4.5	20.6 ± 4.5	0.59 *
	15.4 ± 3.5	18.1 ± 2.9	0.006**
	17.4 ± 3.8	18.3 ± 3.4	0.02***
A4CH GLS	17.0 ± 4.8	18.9 ± 4.2	0.08 *
	17.8 ± 3.6	19.0 ± 2.7	0.8 **
	13.1 ± 0.90	18.7 ± 4.8	0.23 ***
mean GLS	16.0 ± 4.6	18.5 ± 3.5	0.01 *
	16.6 ± 2.1	18.4 ± 1.6	0.01 **
	11.0 ± 1.7	17.0 ± 4.4	0.1 ***
PW	9.5 ± 0.8	7.5 ± 0.7	0.0 *
	10.2 ± 2.2	8.8 ± 1.1	0.03 **
	9.6 ± 1.5	7.6 ± 0.5	0.07 ***
IVSD	9.8 ± 1.4	8.5 ± 0.8	0.01 *
	11.1 ± 2.5	9.5 ± 1.6	0.020 **
	9.3 ± 1.1	7.3 ± 0.7	0.1 ***
AO	29.3 ± 4.8	29.1 ± 3.8	0.7 *
	29.0 ± 4.2	28.7 ± 4.1	0.1 **
	29.0 ± 4.5	24.6 ± 5.0	0.4 ***

Abbreviations: LVEDV: Left Ventricular end-diastolic volume; LVESV: LV End-Systolic Volume; RVFAC: RV Fractional Area Change; AO: Aortic Root; IVSD: Interventricular Septal Diastolic Diameter; PW: Posterior Wall.

***: BMI between 40-45, ** BMI between 46-50, *** BMI >50.**

Discussion

The present study showed that sleeve gastrectomy improves GLS of obese patients after a 9- month follow-up. Previous studies have shown that heart disorders are common in obese patients **(9)**. Using different diagnostic methods to identify high-risk individuals can contribute to reduce mortality rate **(10-12)**; one of these methods is GLS measurement, which can predict patients mortality with heart disorders **(13-15)**.

In addition, present study showed that sleeve gastrectomy can improve cardiac parameters. The mean parameters of PAP, LVEDV, LVESV, LVDD, LVDS were reduced significantly after sleeve gastrectomy; (p-value <0.05). Consistent with our results, the study by Kokkinos et al., also showed echocardiographic parameters improvement after sleeve gastrectomy, indicating an improvement in cardiac function after surgery **(16, 17)**. In addition, Dogdus and associates stated that heart disorders were evident in overweight patients compared to the healthy individuals, due to echocardiographic parameters. However, after weight loss, patients' parameters returned to the normal range, which indicated an improvement in heart function **(18)**.

The study by Santos et al., also showed that sleeve gastrectomy improved heart function by increasing GLS **(19)**. Also Alamdari's study stated GLS increment and heart function improvement after sleeve gastrectomy **(20)**. In the present study, the results also showed that sleeve gastrectomy resulted in increased GLS after surgery.

Previous studies have shown that there is a significant relationship between BMI and heart function. The higher the BMI, the higher the incidence of heart disorders in patients **(21)** will be. The study by

Cavarretta et al., showed reduced BMI in obese patients after sleeve gastrectomy. This decrease was accompanied by improved echocardiographic parameters and heart function **(22)**. The study by Hsuan and coworkers also showed that patients' BMI decreased significantly after surgery, which was accompanied by improved cardiac function, as well as echocardiographic parameters **(23)**. In the present study, lower BMI was observed after sleeve gastrectomy, which was statistically significant. Also the echocardiographic parameters improved in patients after sleeve gastrectomy as well as GLS, indicating an improvement in cardiac function.

Conclusion

Given that that sleeve gastrectomy reduces BMI in obese patients and improves GLS and echocardiographic parameters, it can be stated that GLS performance in obese patients can be used as an important biomarker for identifying high-risk individuals.

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Ethics approval and consent to participate

All the procedures performed in the study involving human participants were in accordance with the ethical standards of local ethics committee of Ahvaz Jundishapur University of Medical Sciences (IR.Tums.MEDICINE.REC.1399.566), as well as the 1964 Helsinki declaration. Written informed consent was obtained from all patients and normal subjects.

Conflict of Interest

The authors declare that they have no conflict of interest.

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