Evaluation of right and left ventricular function using speckle-tracking echocardiography in thalassemic patients

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ABSTRACT

Background : **Beta-thalassemia major is the most common chronic hemolytic anemia among children and adolescents across the world. Several studies have demonstrated that thalassemic patients who have preserved left ventricle systolic function could still have subtle systolic dysfunction. Among patients with beta-thalassemia, early detection of transfusion-induced myocardial iron loading and its intervention with aggressive chelation therapy may delay or reverse heart failure. Two-dimensional speckle-tracking echocardiography (2D-STE) is a novel tool that may detect early myocardial dysfunction in these patients.**

Objective : **The aim of this study was to investigate whether longitudinal strain based on speckle tracking can detect subtle right or left ventricular dysfunction.**

Patients and Methods : **Fifty thalassemic patients with preserved left ventricular ejection fraction (>55%), mean age of 14.75 ± 4.73 years, and thirty age-matched healthy control subjects have been included in the study. Conventional echo Doppler, tissue Doppler echocardiography, and 2D-STE were performed in all patients and control subjects.**

Results : **The right ventricular and left ventricular longitudinal strains were significantly lower in patients than in controls (21.67 ± 5.59 vs. 25.32 ± 2.29, P = 0.001 for right ventricular and 21.29 ± 3.49 vs. 24.90 ± 0.97, P = 0.001 for left ventricular).**

Conclusions : **The 2D-STE can detect early ventricular (left and right) systolic dysfunction in thalassemic patients in the presence of normal systolic function by conventional methods. It may be suggested that the assessment of global longitudinal strain (GLS) can be used as a useful and less expensive tool for screening myocardial iron overload, especially in countries with a limited magnetic resonance imaging (MRI) availability for logistic and economic reasons. Hence, we can refer positive cases with GLS to a higher center to do MRI and start intensive iron chelation treatment.**

Keywords : **Echocardiography, pediatrics, thalassemia**

INTRODUCTION

Beta-thalassemia major is an autosomal recessive hereditary disorder characterized by a homozygous genetic deficiency in the synthesis of beta-globin chains, which causes severe transfusion-dependent anemia.[1] To improve the patient's condition, repeated

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blood transfusions are needed, but these, unfortunately, lead to iron overload.[2]

A unit of red blood cells contains about 250 mg of iron, and the body can excrete approximately 1 mg/day only, A patient accumulates 5 g of iron/year if received 25 units/year, in the absence of chelation.[3] After about 1 year of repeated blood transfusions, iron starts getting deposited in various body organs, including liver, pancreas, cardiac tissues, and other organs. Iron deposition in the cardiac tissues causes degeneration, fibrosis, and dysfunction. Cardiac dysfunction actually represents the leading cause of mortality and morbidity in this group of patients.[4]

Although iron chelator agents can delay or even prevent myocardial dysfunction due to the increased iron burden of cardiac tissues, once dysfunction has become clinically evident it is difficult to reverse.[5,6]

Long-term control of serum ferritin levels to <2500 mg/L[7] protects from cardiac complications and improves survival, with even better outcomes if levels are <1000 mg/L.[8] However, there are factors other than the intensity of blood transfusion that affect serum ferritin levels, such as inflammation/infection, or deficiency of ascorbate, making serum ferritin a poor marker of iron balance with uncertain reliability.[8]

In several studies, the onset of diastolic ventricular dysfunction preceded systolic dysfunction.[9] Hence, ventricular diastolic dysfunction has been shown to be present by conventional and tissue Doppler echocardiography measurements in these patients. However, these measurements have several disadvantages such as limited spatial resolution, angle dependence, and analysis of deformation in only one dimension.[10,11] The recent development of two-dimensional speckle tracking echocardiography (2D-STE) overcomes a lot of these limitations and has the advantage of quantitative assessment of global and regional left ventricular function from two-dimensional images.[12] 2D-STE is a more sensitive tool than conventional echocardiography for early detection of subclinical ventricular dysfunction in several clinical disorders.[13,14]

Aim of the work

The aim of this work was early detection of subclinical ventricular dysfunction in patients with beta-thalassemia major.

PATIENTS AND METHODS

Study design

It is a multi-center, case–control study on pediatric and adolescent patients of beta-thalassemia major.

Patients

Fifty asymptomatic patients diagnosed with beta-thalassemia major and aged below 18 years of age were selected from outpatient clinics and inpatient wards, in Tanta University Hospital and Aswan University Hospital, Egypt, between January 2016 and January 2017.

Patients were excluded from the study if they had any of the following: any structural heart disease (congenital, valvular, rheumatic, or coronary heart disease), left ventricular function <55%, pulmonary artery hypertension, arrhythmia, diabetes mellitus, hypertension, renal and liver disorders, patients with malignancies and inadequate image quality. Thirty healthy subjects were randomly selected and matched to the patient's sex, age, and body surface area as a control group.

Methods

Clinical examination and investigation

Cardiac evaluation of all patients was performed after they had visited the hematology clinic. The laboratory investigations in the form of serum ferritin level and complete blood count were collected at the same time.

Informed consent was obtained from all participants or their parents and the study was approved by the Institutional Ethical Committee.

All participants were subjected to full history taking (heart failure symptoms, comorbid conditions, history of drugs, and history of transfusions), full clinical examination including signs of heart failure.

Echocardiography

At the study entrance, all children were underwent conventional transthoracic echocardiography in the left lateral decubitus position by using (vivid E9, general electric Horten, Norway) ultrasound unit with simultaneous ECG tracing.

The measurements represent a mean of three consecutive cardiac cycles; all participants were in sinus rhythm at the time of examination.

Patients were included if left ventricular ejection fraction >55% and right ventricular function was normal by qualitative assessment.

All echocardiographic parameters were measured within 5 days of blood transfusion as marked anemia can cause high cardiac output failure.

Echo Doppler examination

M-Mode and two dimensional echocardiography: Measuring left ventricular dimensions including both systolic (LVESD) and diastolic (LVEDD) dimensions and ejection fraction (EF%) was obtained by M-mode method,[15] left atrium diameter, left atrial volume index were measured by biplane area-length method in ml.[16]

Tricuspid annular plane systolic excursion (TAPSE) was measured through M-mode across lateral tricuspid annulus in apical four-chamber view.

- Conventional Doppler: The mitral inflow velocities (early [E] and late [A] diastolic velocities) were recorded in the apical four-chamber view with a sample volume of the pulsed wave Doppler positioned at the tip of mitral leaflets during diastole, then E/A ratio was be measured, also the tricuspid inflow velocities of E and A waves were estimated by pulsed Doppler
- Tissue Doppler imaging (TDI): In TDI, the sample volume was positioned at the medial (septal) and lateral sides of the mitral annulus, and the parameters were obtained by averaging the values at the two places of measurements, and also sampling the lateral end of tricuspid annulus in apical four-chamber view to keep the examined area in alignment with the Doppler beam. The velocities of (s) positive systolic velocity and two negative diastolic velocities (the early diastole phase (E') and the late diastole phase (A') waves were then determined. E/e' ratio of both mitral and tricuspid valves was calculated as an index of left ventricular and right ventricular filling pressure, respectively[17]
- Two-dimensional strain by speckle tracking: Two-dimensional grayscale apical views (apical three chamber taken first, this is because timing of aortic valve closure was automatically identified in this view and manually controlled if necessary, then apical four and two-chamber views) were acquired, for three consecutive cycles, the frame rate was adjusted at 50–60 FPS. Images were digitally recorded for subsequent offline analysis using EchoPAC version 113.

In each apical view, three points were determined at the endocardial border, including two basal annular points and the third one is the apical point; the endocardial border after that was automatically traced, manual adjustment of region of interest was done if needed, and then approved for calculation. Then, the system calculated the regional and global longitudinal strain value (GLS) % of the 17 segments eyeball model.[6]

Right ventricular strain was assessed from apical four-chamber view, six-segment model of the right ventricle in the same manner of endocardial trace like left ventricle, and then peak systolic regional and GLS value of the right ventricle were calculated.[18]

The left ventricle and right ventricle during their contraction shorten along their longitudinal axis, so the value of strain is expressed as negative percentage. Less negative strain or decreased absolute value of strain means reduced contractility.[18]

All measurements were performed by an experienced echocardiographer. Intra-observer variability was assessed in 20 randomly selected patients by repeated analysis on the same cine loop.

Statistical analysis

All statistical analyses were performed by SPSS for windows software (Version 25, SPSS Inc., Chicago IL, USA).

Continuous variables were presented as mean ± standard deviation. A Pearson Chi-square test was used to evaluate the significant relationship between categorical variables. Student's *t*-test was used for comparison between parametric values. Correlation analysis was performed by the Pearson coefficient correlation test. $P < 0.05$ was considered statistically significant.

RESULTS

Patient population

We included fifty patients with beta-thalassemia without overt cardiac disease and thirty age- and sex-matched controls. Both patients and controls were evaluated using echo Doppler imaging, including two-dimensional speckle tracking echocardiography.

Clinical and laboratory findings

The demographic data for patients and control group are given in Table 1. Both the groups were matched for both age and sex. The body mass index and body surface area were equivalent in both groups (25.91 ± 1.68 vs. 25.13 ± 2, *P* value = 0.08 and 1.33 ± 0.4 kg/m^2 vs. 1.2 ± 0.26 kg/m^2, $P = 0.14$, respectively).

Resting heart rate was significantly higher in the thalassemic patients than control population (88.48 ± 8.8 vs. 72.1 ± 5.22 b/min, $P < 0.001$).

Serum ferritin level was 2145 ± 756.36 ng/ml, range 1050–4320 in thalassemic patients.

Sex distribution was calculated by Chi-square test, other variables were calculated by independent T test.

Conventional echocardiographic findings

The conventional echo Doppler study showed that left ventricular end diastolic and end-systolic dimensions did not differ between the thalassemia group and control group, while the ejection fraction and left atrial volume index were significantly increased in patient group versus control group (71.67% ± 6.96% vs. 68.88% ± 4.29%, $P = 0.03$ and 30.79 ± 6.05 ml/m^2 vs. 27.28 ± 3.91 ml/m^2, $P = 0.005$, respectively).

There was no significant difference between cases and control group regarding the Doppler inflow velocities of both ventricles, represented by mitral E/A ratio, tricuspid E/A ratio, also no significant difference between the two groups as regard TAPSE [Table 2].

Tissue Doppler echocardiographic parameters

Table 3: The left ventricular and right ventricular filling pressure represented by mitral E/e' and tricuspid E/e' ratio, respectively, showed no statistically significant difference between both thalassemic and control group (P = 0.109, 0.96, respectively), also as regard mitral annular myocardial tissue velocities were similar between patients and controls (all $P > 0.05$).

Ventricular strain

Left and right ventricular strain values for the thalassemic and normal subjects are presented in Table 4. Patients with thalassemia had significantly worse (less negative or reduced absolute value) global left ventricular longitudinal systolic strain than the normal control group (–21.29% ± 3.49% and –24.90 ± 0.97%, respectively, P = 0.001). The left ventricular wall strain values were significantly worse among patients with thalassemia than in normal control group (P = 0. 001).

The right ventricular free wall strain in thalassemic patients was significantly worse than normal patients (21.67% ± 5.59% vs. 25.32% ± 2.29%, P = 0.001).

All right ventricular levels other than the basal level had significantly worse strain than normal patients. At right ventricular middle and apical levels, strain values were significantly worse among patients with thalassemia than in normal control (P = 0.003, $P < 0.001$ respectively), while there was no significant difference between both groups at the basal right ventricular level [$P < 0.15$, Table 4].

A positive correlation was found between ferritin level with global left ventricular longitudinal strain, three chamber, four chamber, and two chamber longitudinal

Table 1: Comparison between beta-thalassemic patients' group and control group as regards clinical and lab data

Parameters	Thalassemia group *n*=50	Control group *n*=30	*P*
Sex, *n* (%)			
Male	28 (56)	11 (36.66)	0.093
Female	22 (44)	19 (63.33)	
Age (years), mean±SD (range)	14.75±4.73 (7-18)	13.83±3.32 (8-17)	0.51
BSA (kg/m^2), mean±SD (range)	1.33±0.4 (0.8-2.25)	1.2±0.26 (0.85-1.85)	0.14
BMI, mean±SD (range)	25.91±1.68 (23-29.5)	25.13±2 (21.5-30)	0.08
Heart rate (beat/min), mean±SD (range)	88.48±8.8 (70-100)	72.1±5.22 (63-80)	<0.001*
Hb (g/dl), mean±SD (range)	7.87±0.88 (5.4-9.2)	12.11±0.63 (11-13.5)	<0.001*
Ferritin ng/ml, mean±SD (range)	2145.28±756.36 (1050-4320)	121.37±27.45 (14-160)	<0.001*

*Statistically significant, Sex distribution was calculated by Chi-square test, other variables were calculated by T independent. BSA: Body surface area. BMI: Body mass index. Hb: Hemoglobin, SD: Standard deviation

Table 2: Conventional echocardiographic data

Parameters	Mean±SD (range)		*P*
	Thalassemia group *n*=50	Control group *n*=30	
LVEDD (cm)	5.1±0.51 (4.3-6.4)	4.92±0.37 (4.4-5.7)	0.096
LVESD (cm)	3.11±0.48 (2.5-4.5)	2.99±0.39 (2.5-3.7)	0.24
LV EF (%)	71.67±6.96 (61-88)	68.88±4.29 (61-78)	0.03*
Mitral E velocity, cm/sec	0.86±0.2 (0.57-1.25)	0.8±0.04 (0.7-0.85)	0.16
Mitral A velocity, cm/sec	0.67±0.17 (0.41-1)	0.62±0.08 (0.57-0.76)	0.14
Mitral E/A ratio	1.42±0.64 (0.7-3)	1.33±0.15 (1.1-1.5)	0.44
LAVI (ml/m^2)	30.79±6.05 (19.2-37.5)	27.28±3.91 (19.2-32)	0.005*
TAPSE (cm)	2.03±0.29 (1.6-3)	2.01±0.32 (1.6-3)	0.71
Tricuspid E/A ratio	1.17±0.17 (0.9-1.5)	1.2±0.19 (0.9-1.6)	0.08

*Statistically significant. LVEDD: Left ventricular end-diastolic dimension, LVESD: Left ventricular end-systolic dimension, LV EF%: Left ventricular ejection fraction %, E/A ratio: The ratio of the early (E) to late (A) ventricular filling velocities, LAVI: Left atrial volume index, TAPSE: Tricuspid annular plane systolic excursion, SD: Standard deviation

Table 3: Tissue Doppler imaging data

Parameters	Mean±SD (range)		*P*
	Thalassemia group *n*=50	Control group *n*=30	
Mitral valve E' (cm/s)	0.18±0.05 (0.11-0.27)	0.19±0.05 (0.12-0.26)	0.27
Mitral valve A' (cm/s)	0.11±0.03 (0.06-0.17)	0.12±0.03 (0.08-0.17)	0.44
Mitral valve S (cm/s)	0.12±0.03 (0.08-0.17)	0.12±0.03 (0.08-0.15)	0.49
Mitral E/e'	4.95±0.98 (3.15-6.5)	4.5±1.31 (3.0-7.08)	0.109
Tricuspid valve S (cm/s)	0.14±0.02 (0.05-0.19)	0.14±0.01 (0.13-0.19)	0.36
Tricuspid E/e'	4.05±0.51 (3-5)	4.05±0.51 (3.2-5)	0.96

Mitral valve E': Mitral annulus early diastolic velocity, A': Mitral annulus late diastolic velocity, S: Annulus systolic velocity, E/e': The ratio of Doppler early diastolic velocity to annulus early diastolic velocity by TDI, SD: Standard deviation, TDI: Tissue Doppler imaging

Table 4: Left and right ventricular myocardial strain characteristics of patients with thalassemia and matched control group

Parameters	Mean±SD (range)		*P*
	Thalassemia group *n*=50	Control group *n*=30	
Global LV strain (%)	−21.29±3.49 (−25.9-−16.4)	−24.90±0.97 (−35-−19)	0.001*
Apical 3-CH view LS (%)	−20.59±5.1 (−27.5-−12.5)	−25.24±2.1 (−29.1-−21.8)	<0.001*
Apical 4-CH view LS (%)	−21.08±2.76 (−25.1-−16.3)	−29.83±5.09 (−40-−23)	<0.001*
Apical 2-CH view LS (%)	−22.17±3.4 (−28-−17)	−32.07±3.52 (−36-−24)	<0.001*
RV free wall strain (%)	−21.67±5.59 (−29.1-−11.7)	−25.32±2.29 (−29.1-−21.8)	0.001*
Basal free wall RV LS (%)	−28.02±5.35 (−40-−18)	−29.73±5.02 (−40-−23)	0.15
Mid free wall RV LS (%)	−28.24±6.28 (−36-−19)	−32.13±3.58 (−36-−24)	0.003*
Apical free wall RV LS (%)	−22.04±9.38 (−35-−3)	−28.87±5.28 (−35-−19)	<0.001*

*Statistically significant. LS: Longitudinal strain, RV: Right ventricular, SD: Standard deviation, CH: Chamber

strain by Pearson's correlation (two-tailed) ($r = 0.581$, $P < 0.001$; $r = 0.434$, $P < 0.001$; $r = 0.565$, $P < 0.0001$; $r = 0.715$, $P < 0.0001$, respectively).

There is a weak positive correlation between serum ferritin level with right ventricular free wall longitudinal strain , middle and apical level of the right ventricular free wall ($r = 0.28$, $P < 0.012$; $r = 0.243$, $P < 0.029$; $r = 0.299$, $P < 0.007$, respectively), meanwhile no correlation between right ventricular basal level strain ($r = 0.085$, $P = 0.451$). On the other hand, a weak correlation was observed between level of ferritin with LA volume index ($r = 0.25$, $P < 0.028$), whereas no correlation was observed between level of ferritin and other parameters of echocardiography [Table 5].

Table 5: Correlation between echocardiographic parameters and ferritin level

Echocardiographic parameters	Ferritin	
	r	*P*
LVEDD (cm)	0.1	0.37
LVESD (cm)	0.01	0.9
LV EF (%)	−0.19	0.08
Mitral E velocity, cm/sec	0.12	0.262
Mitral A velocity, cm/sec	0.14	0.2
Mitral E/A ratio	0.075	0.508
LAVI	0.25	0.028*
TAPSE (cm)	0.09	0.449*
Tricuspid E/A ratio	−0.39	<0.001*
Mitral valve A' (cm/s)	−0.02	0.885
Mitral valve E' (cm/s)	−0.114	0.315
Mitral valve S (cm/s)	0.017	0.883
Mitral valve E/e'	0.168	0.137
Global LV strain	0.581	<0.001*
Apical 3-CH view LS (%)	0.434	<0.001*
Apical 4-CH view LS (%)	0.656	<0.001*
Apical 2-CH view LS (%)	0.715	<0.001*
RV free wall 2D strain (%)	0.28	0.012*
Basal free wall RV LS (%)	0.085	0.451
Mid free wall RV LS (%)	0.243	0.029*
Apical free wall RV LS (%)	0.299	0.007*

*Statistically significant. LVEDD: Left ventricular end diastolic dimension, LVESD: Left ventricular end systolic dimension, LV EF %: Left ventricular ejection fraction %, E/A ratio: The ratio of the early (E) to late (A) ventricular filling velocities, LAVI: Left atrial volume index, TAPSE: Tricuspid annular plane systolic excursion, Mitral valve mitral valve E': Mitral annulus early diastolic velocity, A': Mitral annulus late diastolic velocity, S: Annulus systolic velocity, E/e': The ratio of Doppler early diastolic velocity to annulus early diastolic velocity by TDI, LS: Longitudinal strain, RV: Right ventricular, TDI: Tissue Doppler imaging, CH: Chamber

DISCUSSION

Beta-thalassemia represents the most common cause of hemolytic anemias in Egypt requiring regular blood transfusion and iron chelation therapy to decrease iron overload.

Cardiovascular system is not the first target organ of free iron, but cardiovascular complications are the leading causes of morbidities and mortalities.[19]

Our patients are thalassemia major children, they are transfusion dependent, and their hemoglobin is persistently low. Blood transfusion policy of thalassemic children in Egypt is to keep pretransfusion levels between 7 and 8 g/dl.

When anemia develops chronically – over a prolonged period of time-blood volume is maintained, there are four primary mechanisms of compensation.

Increased cardiac output

The two principal determinants of systemic vascular resistance (SVR) are vascular tone and viscosity of blood. In iso-volumic hemodilution from chronic anemia, the hematocrit decreases and reduces SVR through decreased blood viscosity. The decrease in SVR increases stroke volume and therefore cardiac output and blood flow to different tissues. Oxygen delivery usually remains constant at a hematocrit between 30 and 45%. Further reductions in hematocrit are accompanied by increases in cardiac output (up to 180%) from baseline as hematocrit nears 20%.

Redistribution of cardiac output

When isovolumic hemodilution occurs in chronic anemia, blood flow is redistributed to the tissues with higher extraction ratios (brain and heart). This blood is redistributed to the coronary circulation in a healthy heart and coronary blood flow can increase up to 600% of baseline. When the heart reaches the point at which it can no longer increase cardiac output or coronary blood flow, then it is subjected to possible myocardial injury from decreased oxygen delivery.

Increased oxygen extraction

In times when the hematocrit reaches <25%, the oxygen extraction ratio increases in tissues, leading to an increase in the total body oxygen extraction ratio and to a decrease in venous oxygen saturation. The brain and heart already have a high extraction ratio and there is no increase in oxygen delivery by this mechanism, but tissues such as the kidney, skeletal muscle, and skin compensate in this manner.

Changes in oxygen-hemoglobin affinity

The oxyhemoglobin dissociation curve relates to the partial pressure of oxygen in the blood to the percent saturation of hemoglobin with oxygen. The P50 at 37°C and a pH of 7.4 is 27 mmHg. When anemia develops, the oxyhemoglobin dissociation curve is shifted to the right, whereby hemoglobin has a decreased affinity for the oxygen molecule and releases oxygen to the tissues at higher partial pressures. Since this process occurs only after increased 2, 3 DPG, it occurs only with chronic anemia.[20]

The incidence of iron cardiomyopathy in thalassemic children is about 15%; in early stages, cardiac functions were usually normal until the late stages in the spectrum of iron cardiomyopathy, so it is necessary to anticipate and prevent iron cardiomyopathy before overt heart failure.[21]

Assessment of body iron status in thalassemia is usually done by measuring serum ferritin levels which are indirect and inaccurate methods for iron overload assessment.

Assessment of cardiac iron overload can be assessed directly by T2 magnetic resonance imaging (MRI) or indirectly by echocardiography. Two-dimensional speckle tracking echocardiography is one of the new noninvasive techniques for assessment of ventricular function.[22]

Thalassemic patients show evidence of ventricular systolic dysfunction only in those who present with overt heart failure, which occurs at late stages.[21]

The present study aimed to investigate the diagnostic value of using two-dimensional speckle tracking echocardiography in the detection of subtle ventricular dysfunction in pediatric and adolescent groups of patients with beta-thalassemia major.

As regards the diastolic indices of left ventricle (trans-mitral E/A ratio, mitral E/e') in thalassemic patient group when compared with controls, there was no significant difference between both groups which indicates preserved global left ventricular diastolic function. This is consistent with reports of other studies.[1,23,24]

We found that mitral and tricuspid E/e' ratio shows no significant difference between thalassemia patients when compared with controls. This agreed with authors[1,25] who found that there was no significant elevation in E/e' in the thalassemia patients compared to the control group.

On the contrary, this difference was significant in thalassemia patient compared to controls in other study,[26] who found that there was a significant elevation in E/e' in the thalassemia patients compared to the control group. The difference from our findings can be explained by enrolment of different age groups, different compliance to chelation therapy or difference in iron load.

Assessment of S wave velocity of the lateral margin of the tricuspid annulus showed no significant difference between patients' group and control group, this was contrary to the results of Abdelmoktader and Azer, who found lower (S) wave velocity at basal lateral margin of the tricuspid valve annulus in thalassemic patient group when compared to the control group.[27]

Furthermore, Iarussi *et al.*[28] found that the lateral tricuspid annulus velocities were significantly reduced in the beta-thalassemia patients before transfusion than controls, this could be explained by the difference in the iron load.

The diastolic parameters were not significantly different indicating the absence of overt left ventricular or right ventricular diastolic dysfunction; these results were comparable to the results of Kremastinos *et al.*[29] which showed that left ventricular diastolic function might be well preserved until final stages of the disease.

Normal ejection fraction % does not mean normal myocardial function. Left ventricular ejection fraction is a late and insensitive marker of left ventricular systolic function, and the limitation of the conventional echocardiographic parameters and the superiority of TDI and strain imaging (SI) in the detection of subclinical left ventricular or right ventricular dysfunction have also been demonstrated in other systemic diseases.[29-32] TDI and SI were shown to be effective for detection of left ventricular and right ventricular myocardial dysfunction in patients with amyloidosis,[33] systemic sclerosis,[34] Duchenne muscular dystrophy,[25] and Fabry disease.[35] All these studies indicated that affection of the longitudinal myocardial fibers is a sensitive marker for detection of early myocardial dysfunction.

The aim of the study done by Monte *et al.* was to identify early cardiac affection in thalassemia patients using speckle tracking echocardiography to assess left ventricular rotation and longitudinal mechanics and to look for its relation to iron ferritin level, their study showed that left ventricular mechanics was affected in thalassemia patients and was related to the ferritin level;

in the current study, we use two-dimensional speckle tracking echocardiography to assess left ventricular longitudinal strain, which was affected in thalassemia patient and also was related to the iron overload.[36]

It was reported in other studies that impaired longitudinal and circumferential strain has been found in patients with significant myocardial iron overload.[37,38]

Previous studies performed to assess subclinical affection of diastolic and systolic left ventricular function using tissue Doppler velocity imaging and speckle tracking echocardiography have shown multiple subclinical left ventricular diastolic and systolic dysfunctions despite preserved standard echocardiographic parameters.[14,39]

Ibrahim *et al.*[40] conducted a case–control study with 100 thalassemic patients below 18 years old and 100 healthy controls. The main aim of this study was early detection of myocardial dysfunction in children and adolescents with asymptomatic beta-thalassemia major using standard echocardiography technique and tissue velocity imaging. They found that patients with thalassemia had right and left ventricular systolic dysfunction on the basis of abnormal myocardial velocities.[41]

Piccione *et al.*[42] showed that the global left ventricular longitudinal strain using two-dimensional speckle tracking echocardiography was significantly impaired in thalassemia patients compared with the control group. Similarly, Chen *et al.*[43] showed that longitudinal strain values were significantly lower in adult thalassemia patients who had normal ejection fraction than the healthy controls.[41]

The study of Chen MR *et al.*[43] who evaluated the left ventricular longitudinal, circumferential, and radial myocardial deformation by speckle tracking echocardiography in young B thalassemia patients showed that left ventricle global longitudinal and circumferential strains were lower in the patients with beta-thalassemia than the control group.[43]

Our data, in agreement with previous findings have confirmed that left ventricle GLS was lower in the patients with beta-thalassemia than the control group.

CONCLUSION

The two-dimensional speckle tracking echocardiography can detect early ventricular (left and right) systolic dysfunction in thalassemic patients in the presence of normal systolic function by conventional methods.

Limitations

The limitations are that the use of T2-weighted MRI as a diagnostic tool of iron load was beyond the scope of this study. Our study was based on the echocardiographic parameters. It may be suggested that the assessment of GLS can be used as a useful and less expensive tool for screening myocardial iron overload, especially in countries with a limited MRI availability for logistic and economic reasons.

Future studies can be conducted using cardiac MRI and correlating the findings with the echocardiographic parameters.

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Conflicts of interest

There are no conflicts of interest.

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