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"Evaluation of Cardiac Iron Deposition in Thalassemia Children "

Authors

Walaa Wefky Elsaba [1], Sonya Gamal Elsharkawy [2], Gamal Taha Soliman [2], Mohamed Magdy Abo Elkheir [3], Donia Abd El Kader Sobh [4]

[1] Pediatric and neonatology department

[2] Pediatric and neonatology department, faculty of medicine, Port Said university

[3] Pediatric department, faculty of medicine, Mansoura University

[4] Radiology department, Faculty of medicine, Mansoura University

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https://muj.journals.ekb.egdean@med.psu.edu.eg
vice_dean_postgraduate@med.psu.edu.eg

ABSTRACT:

Background: Blood transfusions are linked to beta thalassemia. The most frequent side effect of blood transfusions is iron buildup in soft tissues, such as the heart muscle. It is well recognised that MRI T2* is an extremely sensitive, non-invasive method for identifying heart issues.

Purpose: to assess how well cardiac magnetic resonance imaging (MRI) can identify myocardial iron accumulation in individuals with beta thalassemia.

Methods: El-Tadamon Hospital provided 50 children with thalassemia for this cross-sectional investigation. Cardiac MRI and echocardiography were used to evaluate each patient.

Results: MRI and Echo were comparable in terms of detecting dilatation of the right and left ventricles; however, MRI significantly overestimated the ejection fraction. Disease duration was significantly longer in cardiac iron deposition group ***(p= 0.035)***. Ferritin was significantly higher in cardiac deposition group ***(p= 0.04)***. Left ventricle ejection fraction was significantly impaired in cardiac iron deposition group ***(p= 0.016)***. Myocardium T2* was significantly lower while myocardium R2 was significantly higher in cardiac iron deposition group ***(p< 0.001, 0.003)***. Myocardium iron concentration was significantly elevated in cardiac iron deposition group ***(p= 0.016)***. Left ventricle was dilated in all cases with cardiac iron deposition ***(p= 0.012)***. Right ventricular volume and volume index were significantly higher in cardiac iron deposition group ***(p= 0.018; 0.001)***. Myocardium T2* correlated significantly to left and right ventricular ejection fractions and end diastolic volumes.

Conclusion: In thalassemia, disease duration, ferritin levels are the main determinant of cardiac iron deposition. Cardiac iron deposition led to significant reduction of left and right ventricular ejection fraction and associated with significant increase of end- diastolic volumes in both sides. MRI and Echo were comparable in detection of chamber dilatation however, MRI overestimated ejection fraction.

Keywords: Thalassemia; Blood transfusion; Hemosiderosis.

Introduction:

One term for β-thalassemia is chronic hemolytic anaemia. Heart deposition is increased in thalassemic individuals with high power circulation. Myocardial ischaemia and tissue fibrosis are typically the results of endothelial dysfunction, intimal remodelling, and peroxidative damage brought on by cellular hypoxia and iron overload. These factors ultimately result in cardiac injury. Children with B-thalassemia may exhibit signs of heart injury, including LV dilatation and LV diastolic dysfunction. One of the main causes of mortality in β-thalassemia major (β-TM) patients is cardiac iron accumulation. Patient survival can be improved and reversed with early diagnosis and therapy ***(Zhou et al., 2023).***

Since it can identify and measure iron deposits in the heart tissue, magnetic resonance imaging (MRI T2*) is considered to be the gold standard for the early diagnosis of iron deposits in cardiac tissue. Transfusion-dependent TM patients now have far higher survival rates thanks to the application of MRI T2* methods. MRI T2* cannot be fully implemented in paediatric TM patients due to the following reasons: this technique requires specialised physicians and technologists, costly instruments and equipment, and examinations; additionally, it cannot be performed in certain hospitals; and finally, preschoolers typically have difficulty cooperating with this technique ***(Ibrahim & Ahmed, 2023).***

The use of MRI to evaluate myocardial iron and function has completely changed how patients with thalassemia major are treated. Although understanding somatic iron storage is essential for managing iron chelation, cardiac risk is not sufficiently monitored by this method. Heart T2* MRI monitoring often enables preclinical identification of myocardial iron, aids in determining future cardiac risk, and monitors response to iron chelation therapy adjustments. According to ***Westwood and Pennell (2019)***, MRI evaluation of cardiac function provides extremely precise evaluations of ventricular function, which is a complement to T2* measures.

Our study's objective was to use cardiac MRI and echocardiography to evaluate myocardial iron deposition and cardiac alterations in paediatric β-TM patients.

Patients and Methods:

Research design and sessions: This was a fifty-patient cross-sectional research with an analytical component conducted at El Tadamon Hospital in Port Said, Egypt. **Approval:** The study was carried out with the consent of the Post-Said University Faculty of

Medicine's institutional review board and ethical committee (ERN : MED (8/12/2021) s.no (27) PED917 (02)

Inclusion criteria: Patients who met all of the following requirements were included in the study: 1. A case of thalassemia is known. 2. The age range was 7–18 years old. 3. The patient has thalassemia and is dependent on transfusions.

Exclusion criteria: Patients who met any of the following criteria were not eligible to participate in the study: 1. Individuals having cardiac defects at birth. 2. People suffering from valvular illness. 3. Recent experience with cardiac failure. 4. The incidence of infectious illnesses recently. 5. Individuals suffering from metabolic conditions. 6. Individuals with long-term liver conditions.
Sample size: Based on patient availability, a reasonable sample size of fifty thalassemia patients was chosen.

Methods: All patients underwent the following:

1. Obtaining the patient's or their carers' medical history, which should include information on age, sex, place of residence, diagnosis onset, number and volume of blood transfusions, iron chelator type and splenectomy.

2. A comprehensive clinical evaluation was performed on each patient including : Vital signs(temperature, blood pressure, heart rate and respiratory rate). General examination: searching for pallor, jaundice,skeletal malformation, lower limb edema…….. . Abdominal examination to detect hepatomegaly ,splenomegaly or signs of liver failure if present

3. All patients had laboratory examinations, which included a complete blood count using the German Sysmex XN-1000 device, which is based on the electrical impedance approach; liver enzymes; and serum ferritin using the Accu Bind Kit in accordance with the Tietz method.

4. Conventional echocardiogram was performed on all patients. The patient had to lie in the left lateral position with their left arm extended behind their head for the parasternal and apical tomographic views. The heart and chest wall are in close touch when the heart is in this posture. The patient had to lie supine for the suprasternal and subcostal views. The collected data from echocardiography examination included left and right ventricular ejection fraction, left and right end diastolic volume. Left and right end diastolic volume index was calculated by dividing end- diastolic volume by body surface area.

5. Siemens scanner-based cardiac MRI (Germany). The method was explained to the youngster and his caretakers. Neither IV contrast nor sedation were applied. It was requested of the patients to lie supine, head first. The patient was able to hear orders to breathe hold because the noise level was lowered by using headphones that were suitable with the MRI equipment. The ECG leads were positioned according to plan. Sensitivity encoding, or SENSE, body coil was employed. It was placed on the chest so that the sternoclavicular notch is just below the midline of its top portion.

Cardiac MRI:

Preparation:

1. The child and his caregivers were informed about the technique.
2. No sedation was needed.

IV. Contrast: No iv contrast was used.

Technique: (positioning and preparatio)

1. The scan was performed with free breathing.
2. **Patient position:** Patients were checked supine and head first. Headphones compatible with the MRI machine were used to reduce repetitive gradient noise, allowing the patient to hear breath hold instructions.
3. **ECG leads position:** The first electrode was put roughly 1 cm to the left of the xiphoid. The second and third electrodes were positioned so that they were roughly 90 degrees apart, with the first electrode forming the right angle. The fourth electrode was put below the first electrode. The QRS complex was verified using the MRI monitor. The patient's heart rate was observed by the MRI monitor
4. **The coil:** The SENSE (sensitivity encoding) body coil was utilized. It was positioned on the chest with the upper part's midline slightly below the sternoclavicular notch.
5. Retrospective ECG – gating was used so that the entire diastolic portion of the cardiac cycle was evaluated.

MRI sequences:

1. Cine Steady State Free Precision (SSFP) in the axial, four chamber, and short-axis views: TR 3.34, TE 1.67, flip angle 55°, 256 × 192 matrix, FOV 340 mm, slice thickness 6-mm, 4-mm interslice gap, 18 phases/cardiac cycle, and two slices per 10-12 second breath-hold. Scan time is around 11 seconds for two slices.

2. T2 star-Weighted imaging: Gradient echo T2∗-weighted imaging can detect and quantify iron accumulation in the heart muscle and liver.The reader will acquire a representative T2* value in areas free of artifacts, while avoiding major vessels and bile ducts. Cardiac T2* examined at eight distinct echo timings. Two sequences were used: breath-hold multi-echo gradient echo (white blood) and double inversion recovery (black blood).

3. T1 maping and sequence: was obtained at basal, mid & apical levels

Image analysis was done using Work Station (WS) (extended MR Workspace 2.6.3.5). Philips Medical System.

1. Volumetric & functional analysis :

Calculated parameters: In the current study, we evaluated left and right ventricular end diastolic volume, left and right ventricular end diastolic volume index, left and right ventricular ejection fraction, left ventricular mass, left ventricular mass index, and left and right ventricular stroke volume in accordance with the research requirements.

Steps:

1. For LV volumetric and functional analysis, contours of endocardial and epicardial borders were drawn at end-diastole and end-systole. The LV end-diastolic image should have the largest LV blood volume, while the LV end-systolic image should have the smallest LV blood volume. For RV volumetric and functional analysis, end canal outcomes were traced in end diastole and end systole using the axial stalk. Z-score values of LV and RV end diastolic

2. T2* Heart:

- Cardiac MR-T2* To avoid susceptibility artifact, values were quantified using a region of interest in the ventricular septum, which was automatically copied to identical positions on images from different TEs. Patients with iron-loaded hearts showed rapid signal loss with increasing TE with both black and white blood sequences, and T2* measures were less than 20 ms. They were classified as mild (15-20), moderate (10-15), or severe (T2*<10 ms).

- Myocardial iron concentration (MIC) was also calculated from R2* using the equation (0.0254*R2) + 0.0202 (R2* the reciprocal of T2*, 1000/T2*), according to Carpenter JP et al. formula, where values ranging from 1.16 to 1.65 indicate light, 1.65 to 2.71 indicate moderate, and more than 2.71 indicate severe cardiac siderosis.

3. T1 mapping:

- Multiple RIO were drown at each of three levels (basal, mid, and apical) of the T1 mapping images.
- The mean T1 mapping value was obtained.
- Z score values for T1 mapping was obtained.

Statistical techniques: SPSS (version 21, Chicago, IL, USA) was used to do the statistical analysis. Quantitative parametric data, which was regularly distributed, was given as means and standard deviations; quantitative non-parametric data, which was abnormally distributed, was provided as median (minimum, maximum); and qualitative data was expressed as numbers and percentages. The subsequent statistical tests were employed: To compare categorical data, the chi-square test was employed. The student t-test is used to compare quantitative data that is normally distributed between two groups. The Mann-Whitney test is used to compare quantitative data that is abnormally distributed between two groups. A statistically significant result was defined as a p value of less than 0.05.

Results:

Patients were divided into two groups based on cardiac MRI results: the no cardiac deposition group consisted of 42 patients, while the cardiac deposition group consisted of 8 patients. 50 children with thalassemia, of both sexes, with a mean age of 11.5 ± 3.5 years, participated in the study. The average age at diagnosis was 3.9 ± 2 years, and the average length of the condition was 7.5 ± 3.3 years. The average length of time for blood transfusions was 6.6 ± 3.3 years, and the average frequency was 8.5 ± 3.5 annually. 42 children (84%) were given various forms of iron chelators, including deferoxamine (6 children), deferiprone (10 children), and deferasirox (26 children). Regarding age, sex, blood transfusion data, and iron chelators, there were no statistically significant differences between individuals with and without myocardial iron deposition.

The group with cardiac deposition had a longer disease duration, with a statistically significant difference (p= 0.035). Skeletal deformity (64%) and hepatomegaly (64%), followed by pallor (62%), tachypnea (62%), and hypotension (60%) were the most frequent clinical findings. Additional clinical observations included splenomegaly (30%), jaundice (46%), and tanned skin (54%). Infrequent clinical symptoms included sclera icterus (28%), and abnormal pulse (16%). The patients who were included had mean haemoglobin levels of 8.7 ± 1.16 g/dL. The average platelet count was 311.18 ± 129.4 while the average white

blood cell count was 6.7 ± 3.4. The mean ALT was 46.13 ± 23.5 and the mean AST was 37.5 ± 6.44. Ferritin values were 2549.3 ± 1230 on average.

Laboratory data, such as liver enzymes and CBC criteria, did not show any statistically significant differences between the cardiac deposition and no cardiac deposition groups. Serum ferritin mean levels were greater in the cardiac iron deposition group compared to the no deposition group, with a statistically significant difference ***(p=0.04) (table 1).***

Table (1): Comparison between different grades of cardiac iron depositions according to myocardium T2* regarding baseline demographics, disease, and treatment data:

	No deposition (n= 42) (84%)	Cardiac iron deposition (n= 8) (16%)	Test of significance	p value
Age (years) Mean ± SD	11.3 ± 3.7	12.6 ± 2.8	t= 0.8	0.35
Sex No. (%) - Male - Female	14 (33.3%) 28 (66.7%)	4 (50%) 4 (50%)	X^2= 0.8	0.32
Disease duration (years) Mean ± SD	7.1 ± 3.2	9.8 ± 2.97	t= 4.6	***0.035***
Splenectomy No. (%)	13 (31%)	4 (50%)	X^2= 1.08	0.3
Duration of blood transfusion (years) Mean ± SD	6.3 ± 3.3	8.5 ± 3.4	t= 3.01	0.09
Frequency of blood transfusion (time/ year) Mean ± SD	6.5 ± 1.19	8.9 ± 3.7	t= 3.16	0.08
Iron chelators No. (%)	36 (85.7%)	6 (75%)	X^2= 0.57	0.45
Hemoglobin (g/dL)	8.7 ± 1.2	8.6 ± 0.69	0.097	0.76
White blood cell (*10^3/mm^3)	6.98 ± 3.3	5.7 ± 0.46	0.72	0.4
Platelets (*10^3/mm^3)	313.8 ± 140.15	297.25 ± 44.24	0.1	0.7
Aspartate aminotransferase (IU/L)	37.3 ± 6.7	38.2 ± 3.9	0.15	0.7
Alanine aminotransferase (IU/L)	46.7 ± 25.11	43.25 ± 13.06	0.14	0.7
Ferritin (microgram/ liter)	1877 ± 919	2677 ± 1379	0.86	***0.04***

t: Student t- test; X^2: Chi square test; Level of significance< 0.05

The results of the echo showed that the left ventricle was dilated in 24 children (48%) and the right ventricle was dilated in roughly 23 children (46%) with a mean ejection fraction of 58.06 ± 6.11%. Each patient's left and right ventricles were functioning normally. Regarding the diameters of the right and left ventricles, there were no statistically significant differences. Table 2 shows that the no deposition group had a greater ejection percent with a statistically significant difference (p= 0.016) ***(table 2)***.

Table (2): Echo cardiography findings differences between patients with and without iron depositions:

	No deposition (n= 42)	Cardiac iron deposition (n= 8)	Test of significance	p value
Right ventricular size: - Normal - Dilated	 21 (50%) 21 (50%)	 6 (75%) 2 (25%)	X^2= 1.69	0.19
Left ventricular size: - Normal - Dilated	 20 (47.6%) 22 (52.4%)	 6 (75%) 2 (25%)	X^2= 2.02	0.155
Left ventricular ejection fraction (%) Mean ± SD	62.75 ± 5.67	57.2 ± 5.8	t= 6.2	***0.016***

t: Student t- test; X^2: Chi square test; Level of significance< 0.05

A cardiac MRI showed a mean T2* score of 32.5 ± 15.79 for the myocardium. The median R2 was 31.7, with a range between 12.4 and 182, and the median MIC was 0.67, ranging from 0.2 to 6.5. In 20 children (40%) the left ventricle was dilated, and the mean left ventricular end diastolic volume and index were 88.4 ± 15.59 mL and 98.3 ± 26.7 mL/m2, respectively. The mean percentage of left ventricle ejection was 62.18 ± 5.8%. With a right ventricular end diastolic volume of 102.76 ± 19.43 and a right ventricular end diastolic volume index of 113.7 ± 30.36, 26 patients (52%) had dilated ventricles.

The ejection fraction of the right ventricle was 60.4 ± 5.7. The T2* value was used to split the children based on the myocardium's iron deposition (42 children had no iron deposition, and 8 had iron deposition). The group without deposition had statistically significant differences in T2* myocardium mean values, with a difference of p<0.001. The cardiac iron deposition group had greater myocardium iron concentration levels, with a statistically significant difference (p=0.016). The cardiac deposition group had a larger percentage of individuals with dilated left ventricles (p= 0.012).

Regarding end diastolic wall mass, end diastolic volume and volume index, left ventricle ejection fraction, and end diastolic wall mass per body surface area, there were no statistically

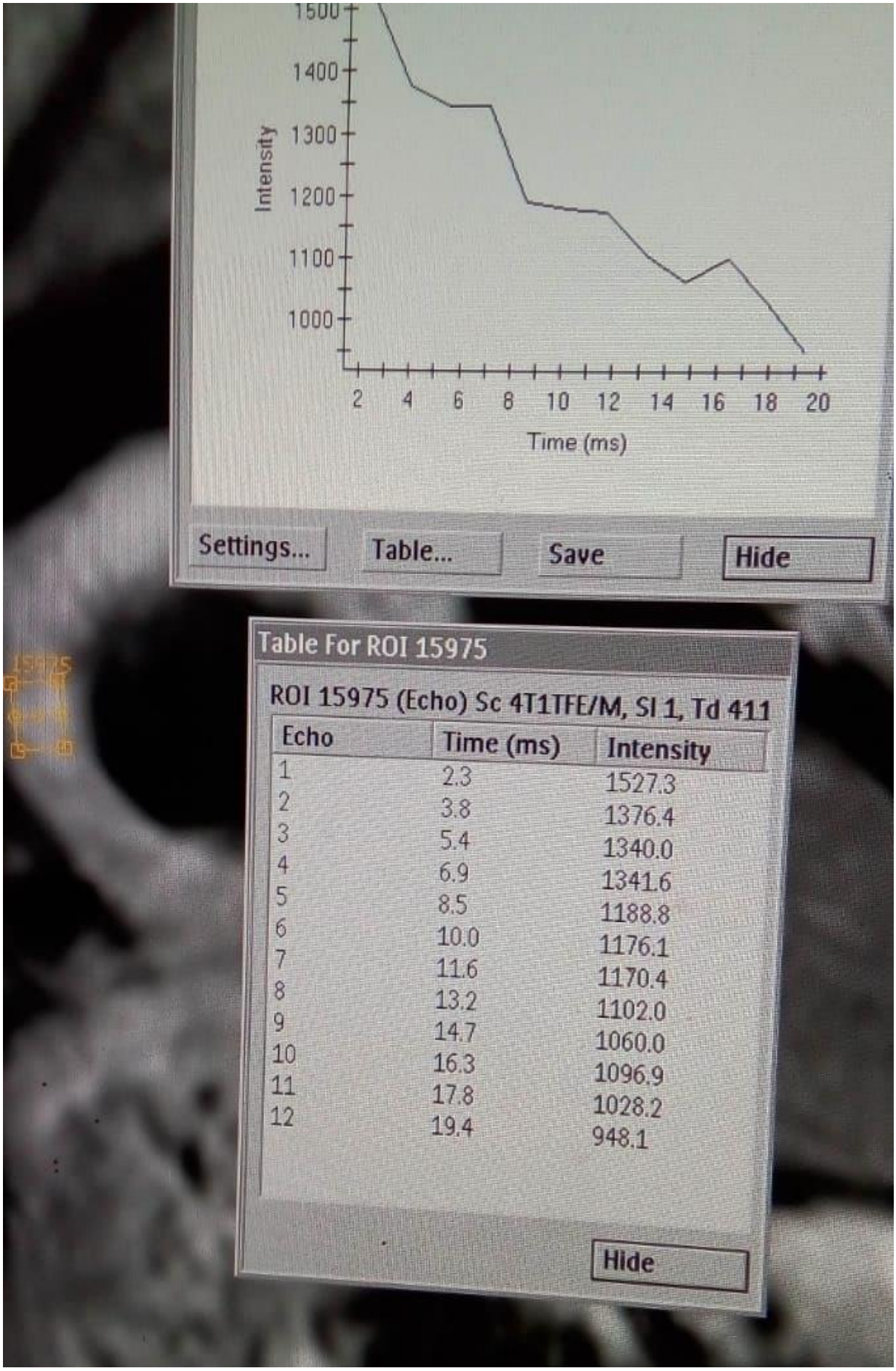
significant differences between the two groups. The right ventricle ejection fraction and right ventricular dilatation did not differ statistically significantly between the two groups. Table 3 shows that there were statistically significant differences in right ventricular end diastolic volume and end diastolic volume index among the cardiac deposition group (p=0.018; 0.001) ***(table 3)***.

Table (3): Cardiac MRI findings differences between patients with and without iron depositions:

	No deposition (n= 42)	Cardiac iron deposition (n= 8)	Test of significance	p value
Myocardium T2*	35.9 ± 14.76	14.62 ± 5.9	t= 16.01	***<0.001***
Myocardium iron concentration (MIC)	0.9 ± 0.3	2.3 ± 0.9	t= -4.45	***0.016***
Myocardium R2	30.2 ± 8.6	80.6 ± 34.5	t= -3.37	***0.003***
LV EDV (mL) mean ± SD	89 ± 15.5	85.7 ± 16.55	t= 0.28	0.59
LV EDVI (mL/ m^2) mean ± SD	96.1 ± 4.6	109.7 ± 36.08	t= 1.7	0.19
LV size: - Normal - Dilated	 22 (52.4%) 20 (47.6%)	 0 8 (100%)	 X^2= 6.34	 ***0.012***
LV EF	62.5 ± 6.1	60 ± 3.8	t= 1.3	0.26
LV ED wall mass (gm)	56.2 ± 16.03	60.17 ± 18.97	t= -0.5	0.61
LV ED wall mass / BSA (gm/ m^2)	53.05 ± 11.4	47.5 ± 5.4	t= 1.14	0.27
RV EDV (mL) Mean ± SD	99.9 ± 16.5	117.5 ± 27.5	t= 6.04	***0.018***
RV EDVI (mL/ m^2) Mean ± SD	107.7 ± 27.5	144.7 ± 26.5	t= 12.24	***0.001***
RV size: - Normal - Dilated	 20 (47.6%) 22 (52.4%)	 4 (50%) 4 (50%)	 X^2= 0.015	 0.9
RV EF (%) Mean ± SD Mean ± SD	60.88 ± 5.7	58 ± 5.5	t= 1.7	0.19

t: Student t- test; X^2: Chi square test; Level of significance< 0.05; LV: Left ventricle; EDV: End diastolic volume; EDVI: End diastolic volume index; EF: Ejection fraction; BSA: Body surface area; RV: Right ventricle; MIC: myocardium iron deposition

When it came to identifying right or left ventricular dilatation, there were no statistically significant differences between the results of Echo and MRI. Nevertheless, there was a statistically significant difference in the mean values of left ventricular ejection fraction between MRI and echo (table 4).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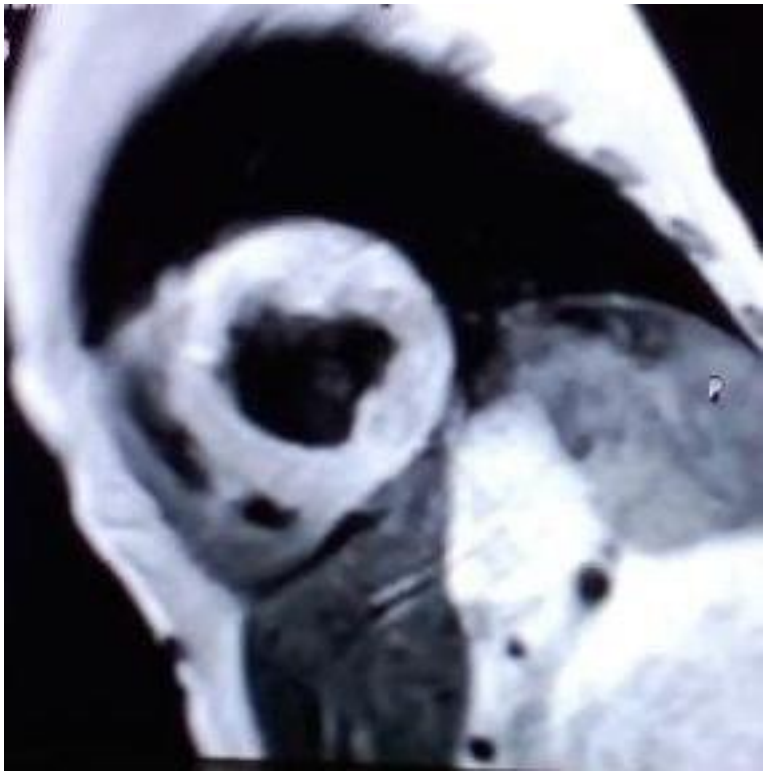

Table (4): Comparison between MRI and Echo findings:

	MRI	Echo	Test of significance	p value
Right ventricular size No. (%): - Normal - Dilated	 24 (48%) 26 (52%)	 27 (54%) 23 (46%)	X^2= 0.3	0.54
Left ventricular size No. (%): - Normal - Dilated	 30 (60%) 20 (40%)	 26 (52%) 24 (48%)	X^2= 0.64	0.42
Left ventricular ejection fraction (%) Mean ± SD	62.18 ± 5.8	58.06 ± 6.11	t= -3.5	***0.008***

X^2: Chi square test; t= student test; level of significance< 0.05

Myocardium T2* and serum ferritin level showed a statistically significant positive connection (r: -0.34; p= 0.016). Myocardium T2* and left ventricular EF (r: 0.44; p: 0.001) or right ventricle EF (r: 0.278; p: 0.04) showed statistically significant relationships. Myocardium T2* and left ventricle end diastolic volume (r: -0.49; p < 0.001) or right ventricle end diastolic volume (r: -0.476; p < 0.001) showed a statistically significant inverse connection. Myocardium T2* and left ventricular end diastolic volume (r: -0.68; p<0.001) or right ventricular end diastolic volume index (r: -0.69; p<0.001) showed statistically significant inverse relationships ***(table 5).***

Table (5): Correlation of demographics, and laboratory investigations and cardiac MR findings to myocardium T2*:

	Correlation coefficient (r)	P value
Age	0.032	0.82
Disease duration	0.13	0.37
Blood transfusion duration	0.15	0.29
Hemoglobin	0.083	0.57
White blood cells	-0.041	0.78
Platelets	0.16	0.27
Aspartate aminotransferase	-0.064	0.66
Alanine aminotransferase	-0.23	0.11
Ferritin	-0.34	***0.016***
Left ventricular ejection fraction	0.44	***0.001***
Right ventricular ejection fraction	0.28	***0.04***
Left ventricular end diastolic volume	-0.49	***<0.001***
Right ventricular end diastolic volume	-0.476	***<0.001***
Left ventricular end diastolic volume index	-0.68	***<0.001***
Right ventricular end diastolic volume index	-0.69	***<0.001***

r: Pearson correlation; Level of significance < 0.05

Discussion:

It has recently come to light that magnetic resonance imaging (MRI) is a very accurate and repeatable method for identifying tissue iron overload and content early on. Owing to the capacity of excess intracellular iron storage to augment the magnetic resonance susceptibility of tissues, magnetic resonance imaging (MRI) has emerged as a noninvasive technique for identifying iron overload in various organs, including the liver, pancreas, and heart, even prior to the onset of symptoms (***Topriceanu et al., 2022).***

Our study's objectives were to assess iron deposition and the relationship between MRI results and iron deposition in paediatric thalassemia patients. In order to accomplish this goal,

we studied 50 children with thalassemia who underwent T2* weighted MRI and echocardiography. The results were then compared with certain laboratory tests.

Age or sex variations between individuals with and without cardiac iron deposition were not observed in the current investigation. Kalekar et al. did not find any statistically significant variations in children's age or sex, which is consistent with the findings of the current study ***(Kalekar et al., 2022).*** Previous investigations ***(Shehata et al., 2019; Heris et al., 2021; Eroğlu et al., 2022)*** that assessed the differences between patients with and without cardiac depositions also showed similar findings.

Long illness duration was linked in our present investigation to increased cardiac iron depositions and reduced myocardium T2*. Additionally, Pennel et al. discovered that a longer duration of the condition was associated with a higher frequency of reduced cardiac T2* ***(Pennell et al., 2008).*** Additionally, Josep and colleagues found a favourable association between the length of the illness and cardiac T2* ***(Josep et al., 2012).*** It seems unlikely that Leung et al. and Shamsian et al. discovered a connection between cardiac T2* and the length of the illness ***(Leung et al., 2009; Shamsian et al., 2012).***

We discovered that there was a non-significant link between T2* and the frequency or length of blood transfusions, and no statistically significant differences were seen between the two groups in this respect. According to Leung et al.'s present investigation, there was no discernible relationship between cardiac T2* and transfusion length or frequency ***(Leung et al., 2009).*** Conversely, Fernandes et al. and Bedoukas et al. demonstrate a noteworthy association between cardiac T2* and frequency and the length of blood transfusion. Additionally, he reported a decrease in EF among patients with cardiac deposition who received more blood transfusions and for longer periods of time ***(Fernandes et al., 2009; Berdoukas et al., 2013).***

Regarding iron chelators, we discovered that there was no statistically significant difference in the current investigation. Alongside this investigation, Leung et al. found no connection between cardiac T2* and chelation treatment (***Leung et al., 2009).*** On the other hand, another research by Fernandes et al. and Bedoukas et al. revealed that patients who did not get chelators had myocardial iron deposition more frequently ***(Fernandes et al., 2009; Berdoukas et al., 2013).***

With the exception of serum ferritin, which was greater in the group with cardiac deposition, there were no appreciable differences between individuals in our research who had and did not have cardiac iron deposition for any of the laboratory tests. According to Kalekar et al.,

the current study is consistent with their findings, which indicate that the moderate group (4625.75), no overload (3719.67), and mild group (2839.38) have the lowest mean values of serum ferritin levels. The severe group has the highest mean value (5936.67). According to ***Kalekar et al. (2022),*** there is a statistically significant difference (P=0.004). Conversely, in contrast to our findings, ***Herzis et al. (2021)*** found a substantial correlation between liver enzymes and cardiac iron accumulation.

As shown in table 2, there was a statistically significant difference in the ejection fraction by Echo between the cardiac iron deposition group and the no deposition group in this study (57.2 ± 5.8 vs. 62.75 ± 5.67). Likewise, Josep et al. and Heris et al. demonstrated noteworthy distinctions between individuals with and without cardiac iron accumulation with respect to the heart's diastolic and ejection fractions ***(Josep et al., 2012; Heris et al., 2021).*** Conversely, Shehata et al. and Leung et al. found no statistically significant variations between the two groups with respect to Echo results ***(Shehata et al., 2019; Leung et al., 2009).***

The results of the cardiac MRI revealed a statistically significant difference in the right ventricular EDV between the groups with and without cardiac deposition, although the left ventricle EDV was similar in both groups. By MRI, the two groups' ejection fractions were similar. Despite these results, table 3 demonstrated a substantial negative association between myocardial T2* and the end diastolic volume of both ventricles and a significant positive correlation between myocardium T2* and the ejection fraction of both sides of the heart. Abdallah et al. discovered no significant link between cardiac T2* and EDV, but they did find a substantial positive correlation between cardiac T2* and EF, which is consistent with these results ***(Abdallah et al., 2021).***

Chu et al.'s 2012 study also discovered a correlation between elevated left ventricular diastolic and systolic dysfunctions and low myocardial T2* values.
There was no discernible relationship between LV EDV and myocardial T2* in the current investigation, however in previous research by Rao et al. Furthermore, he said that there was no discernible relationship between T2 and ejection % ***(Rao et al., 2022).*** Additionally, Abtahi et al. did not discover a significant relationship between LV EDV and cardiac T2* ***(Abtahi et al., 2019).***

He discovered that there was no meaningful relationship between cardiac T2* and ejection fraction in the research of Daar et al. ***(Daar et al., 2009).*** A favourable connection (r=0.19) was found in another investigation between cardiac T2* results and LVEF ***Shamsian et al. (2021)***
In terms of EF, ***Heris et al. (2021)*** found no discernible difference between the cardiac

deposition and no deposition groups. This was in line with the findings of ***Moussavi et al. (2014)***, who found no evidence of a significant relationship between cardiac function and MRI findings.

Variable research pertaining to the link between myocardial T2* and ejection fraction or left ventricular sizes may differ due to the time of the investigations with respect to the commencement of the disease and the initiation of iron chelation. When compared to the gold standard, echocardiography, there were no statistically significant differences in the results obtained from cardiac MR and echocardiography. MRI, on the other hand, demonstrated a high degree of sensitivity and specificity in detecting dilatation of the left and right ventricles. The left ventricular ejection fraction was overestimated by MRI, which was the sole drawback.

According to ***Brittenham et al. (2011),*** who contrasted clinical findings and echocardiography with the current data, cardiac MR-T2* is the most robust biomarker for the simultaneous assessment of liver and heart iron overload. According to Augur et al., cardiac MRI was very sensitive and specific in identifying iron-induced cardiac problems, such as arrhythmia and heart failure, in patients with tuberculosis (TM) ***(Auger & Pennell, 2016).***

To sum up, Cardiac MRI and Echo were comparable in detection of volume dilatation. However, MRI overestimated ejection fraction. Disease duration and serum ferritin were the main determinants of cardiac iron deposition. Cardiac iron deposition resulted in significant reduction of ejection fraction and dilatation of left and right ventricles. Myocardium T2* showed significant positive correlations to ejection fraction and negative correlations to end-diastolic volume and volume indices.

List of abbreviations:

Abbreviation	
MRI	Magnetic resonance imaging
B- TM	Beta Thalassemia major
Echo	Echocardiography
MIC	Myocardium iron concentration
IV	Intravenous
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
R	Pearson correlation
LV	Left ventricle
RV	Right ventricle
EF	Ejection fraction
LV EDV	Left ventricle end- diastolic volume
LV EDVI	Left ventricle end- diastolic volume index
RV EDV	Right ventricle end- diastolic volume
RV EDVI	Right ventricle end- diastolic volume index

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