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Original Article

Assessment of hepatic and cardiac iron overload in thalassemia patients by magnetic resonance imaging: Our experience in Alexandria University

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ABSTRACT

Aim of the study: The aim of this study was to assess the utility of MRI as a non-invasive technique for grading of the hepatic and cardiac iron overload in Thalassemia patients in a cohort of patients in Alexandria, Egypt.
Patients and methods: The study included 80 known patient with Thalassemia on repeated blood transfusion referred from internal medicine department (hematology unit) to the radiology department at Alexandria main university hospital. A 1.5-Tesla MR scanner was used (Achieva; Philips Medical Systems, the Netherlands) equipped with a standard five-element synergy cardiac coil.
Results: The myocardial iron overload among our cases were as follow: 73 cases (91.3%) with no overload, 5 cases (6.3%) with mild overload, one case (1.3%) with moderate overload and also only one case (1.3%) with sever iron overload. The hepatic iron overload among the studied cases were as follow: 20 patients (25%) with no overload, two patients (2.5%) were upper normal overload, 9 cases (11.3%) with mild overload, 47 patients (58.8%) with moderate overload and only two patients (2.5%) with sever overload.
Conclusion: Most thalassemia major patients in our study, who had no regular chelation therapy, had hepatic iron overload, less frequently myocardial iron overload.

1. Introduction

Thalassemia is a hereditary haemolytic anaemia that results in a haemoglobin synthesis disorder and is common among Mediterranean populations [1].

The treatment of choice for thalassemia patients is blood transfusions. Although a life-saving measure, repeated transfusions result in iron deposition within the tissues. This iron overload is exaggerated by intestinal iron absorption stimulated by tissue hypoxia, apoptosis of defective erythroid precursors generated by ineffective erythropoiesis, and haemolysis of native and transfused red blood cells [1].

After repeated transfusions without the use of appropriate chelation therapies, the resulting accumulation of iron may cause endocrine and cardiac dysfunction, hepatic effects, and finally, patient death, which commonly occurs in the second decade of life [1].

Currently, despite the use of repeated blood transfusions, life expectancies have started to increase in countries where modern chelation therapy is used. While cardiac iron overloads are reversible and preventable in most cases, the worldwide survival rate remains low [2].

Echocardiography (ECG), serum ferritin levels and liver biopsies were once the most commonly used methods for detection of iron overload; however, it is important to assess hepatic and cardiac iron deposits to monitor the need for chelation therapy and to establish an early diagnosis of organ haemosiderosis to avoid organ failure [3–5].

Our goal was to use non-invasive imaging techniques to assess cardiac and hepatic iron overloads in these patients. Specifically, MRI was used, which exhibits a good correlation with the invasive method of biopsy.

Unfortunately, the majority of thalassemia patients live in developing countries that administer only chelation therapy irregularly and later in patients' lives. Additionally, the availability and awareness of the use of MRI is not very widespread, and consequently, patients experience tissue iron overload followed by organ failure and early death [6].

2. Aim of the study

Aim: the aim of this study was to assess the utility of MRI as a non-invasive technique for grading of the hepatic and cardiac iron overload in Thalassemia patients in a cohort of patients in Alexandria, Egypt.

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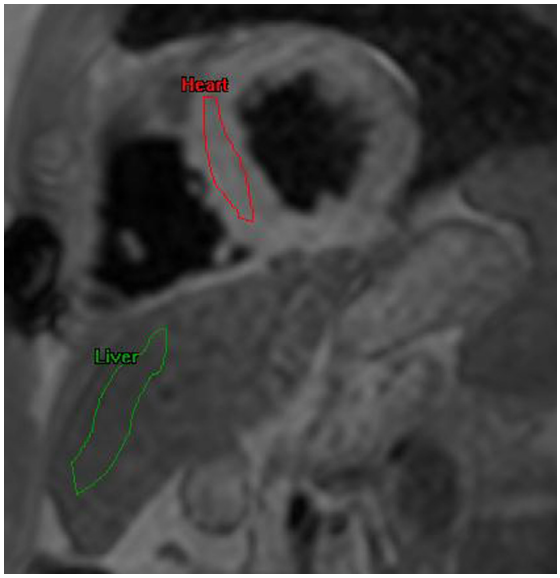

Fig. 1. How to measure … Drawing a region of interest (ROI).

Table 1
Distribution of the studied cases according to different parameters (n = 80).

Age (years)	24 (8–53)
< 10	4 (5%)
10–20	27 (33.8%)
21–30	37 (46.3%)
> 30	12 (15%)
Sex	
Male	25 (31.3%)
Female	55 (68.8%)
T2* Myocardium (ms)	32 (7–50)
No Overload	73 (91.3%)
Mild Overload	5 (6.3%)
Moderate Overload	1 (1.3%)
Sever overload	1 (1.3%)
T2* Liver (ms)	3.8 (1.7–45)
No overload	20 (25%)
Upper normal	2 (2.5%)
Mild overload	9 (11.3%)
Moderate overload	47 (58.8%)
Sever overload	2 (2.5%)
Serum ferritin	1700 (200–7566)

3. Patients and methods

The study included 80 patients with known thalassemia major, illness started from childhood as it was variable among patients, they are receiving repeated blood transfusions with Desferrioxamine was used as an iron chelating agent. These patients were referred from the internal medicine department (haematology unit) to the radiology department at Alexandria's main university hospital.

We excluded patients with primary cardiac or hepatic diseases that may affect our measurements.

The study protocol was approved by the Research Review Committee of the Alexandria Faculty of Medicine, and informed consent was obtained from each subject included in the study.

A 1.5 – Tesla MR scanner that was equipped with a standard five-element synergy cardiac coil was used (Achieva; Philips Medical Systems, the Netherlands).

An ECG-gated multi-echo gradient echo sequence (8 TE values) was then acquired as a single mid-ventricular short-axis slice for myocardial T2∗ measurement. We started with TE 1.3 then 2.4, 3.5, 4.6, 5.7, 6.8, 7.9 and 9 ms. The scan was performed in an average of 10 min.

In each case, a region of interest was drawn within the interventricular septum of the single short-axis slice at all 8 echo times for measurement of the myocardial T2∗ value. Another region of interest was drawn as large as possible within the visualized part of the right hepatic lobe (away from blood vessels) for concomitant measurement of the hepatic T2∗ value (Fig. 1).

Manual calculations of these values were obtained by fitting the decay curves of the original images using the truncation method.

4. Results

The study included 80 patients: 25 males (31.3%) and 55 females (68.8%) (Table 1). The ages of the patients ranged from 8 to 53 years, with a mean of 24 years (Table 1).

The serum ferritin levels in the studied patients ranged from 200–7566 ng/l, with a mean value of 1700 (Table 1).

The myocardial iron overload characteristics among our patients were as follows: 73 (91.3%) had no overload, 5 (6.3%) had mild overload, one (1.3%) had moderate overload, and one (1.3%) had severe overload (Table 1) (Fig. 2).

The hepatic iron overload characteristics among the studied cases were as follows: 20 (25%) had no overload, two (2.5%) had an upper normal overload, 9 (11.3%) had mild overload, 47 (58.8%) had moderate overload, and only two (2.5%) had severe overload (Table 1) (Fig. 3).

No significant relationship was observed between the hepatic and cardiac iron overloads among the studied cases (Table 2). The numbers and percentages of cardiac and hepatic iron overloads among the studied cases are compared in Table 2.

No significant relationships were observed in terms of the presence or absence of iron overload between the myocardium and liver (Table 3). The numbers and percentages of cases of myocardial iron overload are summarized in Table 3. Seven patients had myocardial iron overload, 73 patients had no myocardial iron overload, 20 patients had no hepatic iron overload, and 60 patients had hepatic iron overload.

A significant relationship was observed between serum ferritin levels and hepatic as well as cardiac iron overload (Table 4).

A significant relationship was noted between the two studied groups in terms of hepatic and cardiac iron overload and the serum ferritin level (Table 5).

A positive correlation was found between hepatic and cardiac iron overload (Fig. 4).

A negative correlation was observed between the myocardial T2∗ values and serum ferritin levels (Fig. 5).

A negative correlation was noted between the hepatic T2∗ values and serum ferritin levels (Fig. 6) (see Table 6).

5. Discussion

Thalassemia is a serious disease; therefore, the use of accurate, non-invasive, rapid and single MRI sequences such as T2∗ for the detection and quantification of cardiac and hepatic iron overload, as well as ventricular function, is a major step for the monitoring of chelation therapy and the diagnosis of organ siderosis among thalassemia patients [4].

Physicians must be aware of the effects of repeated blood