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ORIGINAL ARTICLE

Contrast Sensitivity in Patients with β-Thalassemia Major: A Cross-Sectional Study

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Abstract:

Objective: To assess the contrast sensitivity in patients with β-Thalassemia major using reliable testing methods.

Methods: This observational cross-sectional study was conducted at Fatimid Foundation Hospital, Hayatabad, from Sep 1, 2019, to Mar 1, 2020. The sample size of 44 patients was selected from those aged 15–40 years with β-thalassemia major, a transfusion history of 360–600 units, and visual acuity of ≥6/9. Visual acuity was measured using the Snellen chart, while contrast sensitivity was measured using the Pelli-Robson chart at a 3-metre distance. Frequencies and percentages were calculated; ANOVA and chi-square tests were used to analyze data in SPSS V27.

Results: Out of 44 patients, females comprised a high percentage (59.1%), while rural residents were more common (63.6%). Most of the patients were aged between 15–20 years (59%). Contrast thresholds showed 4.5% with <2.5, 31.8% with 2.5, and 63.6% with >2.5, with a significant difference between groups (ANOVA: F=25.6, p<0.001). In word recognition, most patients in both age groups recognized 11–20 words. Blood transfusion volume was significantly associated with word recognition, with those receiving 360–480 ml showing higher odds of better performance (OR=6, p=0.0044).

Conclusion: The contrast sensitivity was reduced in β-thalassemia major patients, suggesting that ocular examination, like contrast sensitivity and visual acuity, should be tested on a routine basis to detect early ocular involvement. *Al-Shifa Journal of Ophthalmology 2026; 22(1): 17-22.*

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Introduction:

Thalassemia is considered to be the most common inherited blood disorder, often leading to various eye problems. These issues may stem from the disease itself, iron buildup caused by frequent blood transfusions, or side effects of medications used to remove excess iron[1-3]. Regular blood transfusions are often the main treatment for several severe or refractory anemias, especially beta-thalassemia major (BTM) and sickle cell disease (SCD)[4]. Although regular transfusions help prevent death from severe anemia in infancy and allow normal growth and development in childhood, they also cause iron to build up in the body. Over time, this excess iron can become toxic and lead to organ damage or failure [5]. Contrast sensitivity was lower in beta-thalassemia major patients and sickle cell patients at all spatial frequencies; it was reduced mainly at low and medium frequencies. A likely reason for these

changes is the toxic effect of deferoxamine. This drug can cause toxic retinopathy, which may appear as pigment changes in the retina, bull's-eye maculopathy, or vitelliform-type maculopathy[6]. In 2000, Gartaganis et al., 2000[7] studied contrast sensitivity in patients with β-thalassemia major who were receiving regular blood transfusions and subcutaneous DFO treatment. They used the Vector Vision CSV-1000 contrast sensitivity test and found that contrast sensitivity was significantly lower in all thalassemia patients compared to healthy individuals. They also found a significant difference, especially at spatial frequencies of 2, 3, and 6 cycles per degree (cpd), showing reduced contrast sensitivity in thalassemia patients[8,9]. Later, in 2010, Spyridon et al., 2010[10] used the B-VAT II SG Mentor Visual Acuity Tester to measure contrast sensitivity in similar patients. Due to the high number of β-thalassemia cases in the Iranian population, especially in the northern regions, and the eye problems that can affect their quality of life, it is important to check their contrast sensitivity. A very simple and cost-free, reliable test can be used for the detection of any ocular complications for the prevention of complications[11]. This study aims to address this important gap in patients' quality of life, while assessing contrast sensitivity using a simple method is essential.

Methodology:

A cross-sectional observational study conducted at the Fatimid Foundation Hospital, Hayatabad Phase 1. A convenience sampling technique was used for sampling. Using the formula $n = Z^2 * p(1-p) / e^2$, and 95% confidence level (Z=1.96), p=0.5, and a margin of error around ±5% our sample size was 44. The duration for this study was 6 months, i.e., from September 1, 2019, to March 1, 2020. After obtaining official permission from the hospital authority, informed consent was obtained from the patients. Medical histories were taken from all patients, and an eye examination was conducted. Patients were included who had a history of blood transfusion of blood of 360-480 and 504-600 units, β-Thalassemia Major, and other systemic illnesses. In this study, we excluded participants with pathological eye conditions or other systemic diseases like diabetes, which can negatively impact the ocular system. Additionally, the thalassemia patients who have refractive errors were excluded, especially in high myopia. Initially, the visual acuity of the patients was recorded by the Snellen visual acuity chart, followed by contrast sensitivity measurements at a distance of 3 meters using the Pelli-Robson Chart. The age of the patients ranged from 15-40 years, with visual acuity of 6/9 or better in both eyes documented in the record form. Frequencies and percentages were calculated for qualitative data, and ANOVA and chi-square tests were applied to check the association within and between the groups using SPSS version 27.

Results:

Out of total 44 patients, most of the patients were female, from rural areas, and belonged to the age group 15–20 years and majority had contrast sensitivity above 2.5 log units. The inferential statistics ANOVA results showed a significant difference in contrast sensitivity across the three groups. At 3 meters, Word-recognition scores were generally higher in both age groups, with many patients recognizing 11–20 words. Most patients had received 360–480 units of blood transfusion. The association analysis further showed that patients with moderate transfusion levels reported a significantly better visual performance, while those with higher transfusion volumes did not show a statistically significant association.

Table 1: Demographics of the Patients

Variables	N(%)
Gender	
Male	18 (40.9%)
Female	26 (59.1%)
Area	
Urban	16 (36.4%)
Rural	28 (63.6%)
Age	
15-20 years	26 (59%)
21-25 years	18 (40.9%)
Log Unit of Contrast	
< 2.5	2 (4.50%)
2.5	14 (31.8%)
> 2.5	28 (63.6%)

Table 2: One-Way ANOVA – Comparison of Log Unit of Contrast Across Three Groups.

Log Unit of Contrast Group	N	Mean + SD Log Unit of Contrast	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
< 2.5	2	2.3±0.1					
2.5	14	2.5±0.0					
> 2.5	28	2.7±0.1					
Between Groups			0.32	2	0.16	25.6	<0.001
Within Groups			0.256	41	0.00624		

Table 3: Words recognized by the Patients at 3 Meters and the Total number of Blood transfusions.

Variables	Word Count	N(%)
Age (15-20 years)	5–10-word count	6 (13.60)
	11-15 words count	10 (22.70)
	16-20 words count	10 (22.70)
Age (21-25 years)	5–10-word count	2 (4.50)
	11-15 words count	10 (22.70)
	16-20 words count	6 (13.60)

Table 4 shows the Total number of Blood transfusions, frequency, and percentage.

Number of blood transfusions	N(%)
360-480 blood volume units	26 (59.00)
504-600 blood volume units	18(40.90)

Table 5: Contrast sensitivity association with the Total number of Blood transfusions.

Total Number of Blood Transfusions	Words Recognized	(OR)	CI 95%	Chi-square	p-value
360-480	30	8.33	(3.36, 20.49)	8.109	0.0044
504-600	18	2.41		8.33	0.144

Discussion:

In the present study, 44 patients with β-thalassemia major were evaluated to determine contrast sensitivity using the Pelli-Robson chart. More than half of the participants were female (59.1%), and were from the rural areas (63.6%). The most of the age group patients were from 15–20 years (59%). Our findings reported that there is a significant reduction in contrast sensitivity among patients with β-thalassemia major, despite of having relatively normal visual acuity (VA).

Contrast sensitivity is a crucial visual function that may help to detect subtle visual impairment even when visual acuity measured by the Snellen chart remains normal. Mitchell et al., 1987 reported that the contrast sensitivity testing helps us to identify the early visual dysfunction earlier than conventional visual acuity measurements in the certain ocular and systemic eye conditions[11]. Similarly, Woods et al., 2009 also demonstrated that the contrast sensitivity testing is much more sensitive than the Snellen chart to detect the early visual abnormalities [12].

Previous studies have also showed that ocular complications in patients with β-thalassemia major may be related to increasing age, iron overload due to repeated transfusions, and the use of iron chelation therapy such as deferoxamine. Gelmi et al., 1993 and Rinaldi et al., 1988 reported that patients with thalassemia major may develop visual function abnormalities even in the absence of obvious structural eye changes.[7,8] In the present study, we focused on the contrast sensitivity as an indicator of early visual dysfunction that may help clinically visible ocular abnormalities.

Our findings are consistent with the observations of Gartaganis et al., 2000 who reported that patients with β-thalassemia major had significantly lower contrast sensitivity compared with healthy individuals despite having normal visual acuity on the Snellen chart[7]. This reduction in contrast sensitivity was observed across different spatial frequencies, suggesting early functional impairment of the visual pathway.

In our study, patients receiving lower volumes of blood transfusions (360–480 units) reported better word recognition performance compared with those receiving higher transfusion volumes (504–600 units). This finding suggests that repeated transfusions and the resulting iron overload may lead to subtle retinal dysfunction. Spyridon et al., 2010 similarly reported decreased contrast sensitivity in patients with β-thalassemia major and sickle cell disease receiving regular transfusion therapy[10]. The reduction in contrast sensitivity observed in thalassemia patients may be linked with several ocular complications associated with the disease. These includes; lens opacities, macular degeneration, retinal vascular abnormalities, and degeneration of the retinal pigment epithelium. Such pathological changes may occur due to chronic anemia, hypoxia, iron deposition in ocular tissues, or toxicity related to chelation therapy.

Gartaganis et al., 2000 also showed that although slit-lamp examinations were normal in many patients, FFA revealed that the retinal pigment epithelium degeneration and angioid streaks are in approximately 13% of cases[7]. Furthermore, the decrease in the contrast sensitivity was more noted in the patients with detectable retinal pathology.

Several studies have reported that the relationship between ocular complications and factors such as serum ferritin levels, duration of transfusion therapy, and chelation treatment. However, in our study, no significant association was found between contrast sensitivity and the duration of transfusions, chelator dose, or ferritin levels. These findings are similar to the results as reported by Gartaganis et al., 2000 [7], who suggested that chronic retinal hypoxia may play a more significant role in visual dysfunction than transfusion duration or ferritin levels alone.

A few studies provide complementary, but different, views of eye findings in beta-thalassemia in a nutshell. A high prevalence of diverse structural and functional abnormalities such as lens opacities, dry eye, visual field defects, and retinal degeneration (RPE) in asymptomatic patients in comparison to 19.4% of controls (68.5% vs. controls, p=0.005) and a specific, reversible retinal toxicity from desferrioxamine. Our study provides the functional vision measures (contrast sensitivity and word recognition) in a comparable young population (primarily 15-20 years) and shows that most patients have good functional vision, with moderate transfusion volumes (360-480 units) correlating with improved functional vision performance.[13-16] It is noteworthy that none of the patients in the present study demonstrated obvious structural ocular abnormalities during routine clinical examination. However, previous studies have reported that subtle retinal changes can be detected using advanced diagnostic techniques such as electro diagnostic testing, fluorescein angiography (FFA), and visual field (VF) analysis[17].

Despite providing useful insights to this, the present study has several limitations. The sample size was relatively very small, which may limit the generalizability of the findings. Additionally, advanced diagnostic investigations such as electro diagnostic testing or fluorescein angiography (FFA) were not performed, which could have detected subtle retinal abnormalities. Moreover, the cross-sectional design of the study prevents the development of the causal relationships between transfusion therapy, chelation treatment, and contrast sensitivity changes.

Another limitation of this study is that differences in the administration routes and patient compliance associated with various iron chelators were not considered. Deferoxamine requires prolonged subcutaneous infusion, whereas newer oral chelators such as deferiprone and deferasirox provide easier administration and may influence treatment adherence and clinical outcomes.

Conclusion:

This study concluded that the contrast sensitivity is significantly reduced in patients with β-thalassemia major despite having normal visual acuity. These findings suggest that contrast sensitivity testing may help to detect early visual dysfunction before the appearance of clinically evident ocular abnormalities. Routine ophthalmic screening, including contrast sensitivity assessment, may therefore be beneficial for early identification and management of ocular complications in patients with β-thalassemia major.

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