Postprint: Assessment of Vision-Related Quality of Life and Analysis of Influencing Factors in Low Vision Patients with Myopic Maculopathy

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Abstract

Background Myopic maculopathy causes irreversible fundus structural damage and functional impairment, severely impacting the lives of elderly patients. Currently, there are no reports on the quality of life assessment in low vision patients with myopic maculopathy, and its influencing factors remain inconclusive. Objective To assess the current status of vision-related quality of life in low vision patients with myopic maculopathy and explore its association with visual function, lesion characteristics, and other factors. Methods Forty low vision patients with myopic maculopathy who visited the ophthalmology outpatient clinic of Shanghai First People' s Hospital from September 2022 to January 2023 were enrolled. Vision-related quality of life was assessed using the Low Vision Quality of Life Questionnaire (LVQOL). Best-corrected visual acuity (BCVA) and contrast sensitivity (CS) were measured, and ATN grading and choroidal thickness were recorded based on color fundus photography and optical coherence tomography. Pearson correlation analysis and Spearman rank correlation analysis were employed to explore the correlations between vision-related quality of life and ocular parameters and ATN grading. Hierarchical regression analysis was used to evaluate the moderating effect of the worse eye on the visual function of the better eye, and a generalized linear regression model was utilized to further identify the influencing factors of vision-related quality of life. Results Correlation analysis revealed that LVQOL scores were negatively correlated with BCVA in the better eye (r=-0.921, P<0.001), positively correlated with CS in the better eye (r=0.943, P<0.001), and positively correlated with CS in the worse eye (r=0.32, P=0.044). Hierarchical regression analysis demonstrated that the interaction between worse eye and better eye BCVA had a statistically significant effect on total LVQOL score (β=8.25, P<0.001). LVQOL scores were negatively correlated with atrophic lesion grading (r=-0.827, P<0.001) and neovascular lesion grading (r=-0.802, P<0.001). Generalized linear regression analysis revealed that LVQOL scores were positively correlated with gender (β=3.93, P=0.011)

and choroidal thickness in the better eye (β=0.08, P=0.007). Conclusion BCVA, CS, severity of ATN grading, and choroidal thickness in the better eye are key factors affecting vision-related quality of life. Future treatment strategies should emphasize visual function improvement, structural index monitoring, and comprehensive disease management to improve patients' quality of life.

Full Text

Evaluation of Vision-Related Quality of Life in Myopic Macular Degeneration Patients with Low Vision and Analysis of Influencing Factors

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Abstract

Background: Myopic macular degeneration causes irreversible structural and functional damage to the fundus, seriously affecting the lives of elderly patients. Currently, there are no reports evaluating the vision-related quality of life in myopic maculopathy patients with low vision, and the factors affecting it remain inconclusive.

Objective: To assess the vision-related quality of life in myopic macular degeneration patients with low vision and explore its association with visual function and disease characteristics.

Methods: Forty patients with myopic macular degeneration and low vision who attended the ophthalmology clinic of Shanghai General Hospital from September 2022 to January 2023 were included. Vision-related quality of life was assessed using the Low Vision Quality of Life Questionnaire (LVQOL). Best-corrected visual acuity (BCVA) and contrast sensitivity (CS) were measured, and ATN grading and choroidal thickness were recorded based on color fundus photography and optical coherence tomography. Pearson and Spearman correlation analyses were used to examine the relationship between vision-related quality of life and ocular parameters/ATN grading. Stratified regression analysis evaluated the moderating effect of the worse eye on the impact of the better eye' s visual function on quality of life, and a generalized linear regression model was used to further confirm the influencing factors of vision-related quality of life.

Results: Correlation analysis showed that LVQOL scores were negatively correlated with BCVA in the better eye (r = -0.921, P < 0.001), positively correlated with CS in the better eye (r = 0.943, P < 0.001), and positively correlated with CS in the worse eye (r = 0.32, P = 0.044). Hierarchical regression analysis showed that the interaction between worse eye and better eye BCVA had a statistically significant effect on total LVQOL score ($\beta = 8.25$, P < 0.001). LVQOL scores were negatively correlated with atrophic lesion grading (r = -0.827, P < 0.001) and neovascular lesion grading (r = -0.802, P < 0.001). Generalized linear regression analysis showed that LVQOL score was positively correlated with sex ($\beta = 3.93$, P = 0.011) and choroidal thickness in the better eye ($\beta = 0.08$, P = 0.007).

Conclusion: BCVA, CS, severity of ATN grading, and choroidal thickness in the better eye are key factors affecting vision-related quality of life. Future treatment strategies should focus on visual function improvement, structural index monitoring, and comprehensive disease management to improve patients' quality of life.

Keywords: Low vision; Myopic macular degeneration; Quality of life; Questionnaire; Influencing factors

1. Introduction

Low vision patients are those who, after treatment or standard refractive correction, still cannot overcome their visual impairment but have the potential to utilize their residual visual function to participate in life and work [1]. China has approximately 12 million people with visual disabilities, including about 8 million with low vision and 4 million who are blind, with numbers increasing annually [2]. Due to impaired visual function, low vision patients experience difficulties in daily activities such as walking and reading, resulting in severely decreased quality of life and imposing heavy family and socioeconomic burdens.

Pathological myopia has become the leading cause of irreversible blindness in China [3]. The structural and functional damage to the fundus caused by myopic macular degeneration cannot be recovered, and surgical and medical treatments can only delay disease progression to some extent [4]. When evaluating the impact of myopic macular degeneration on patients, ophthalmologists often rely on objective indicators such as visual acuity while overlooking the effects of visual impairment on daily functional activities and psychological well-being. In recent years, the transformation of medical models has brought increased attention to the assessment of vision-related quality of life in these low vision patients. Current research on vision-related quality of life has primarily focused on cataract, glaucoma, and age-related macular degeneration [5-9], with no reports evaluating the quality of life in low vision patients with myopic macular degeneration, and its influencing factors remain undetermined.

This study aims to quantitatively assess the vision-related quality of life in low vision patients with myopic macular degeneration, explore the impact of visual function and disease type/severity on their daily living abilities, enhance understanding of the disease burden, and provide reference for clinical diagnosis, treatment, and rehabilitation approach selection and development for low vision populations.

1.1 General Information

This cross-sectional observational study included 40 patients (80 eyes) with low vision due to myopic macular degeneration who attended the ophthalmology clinic of Shanghai General Hospital from September 2022 to January 2023. All patients had received proper treatment for their primary disease but still had vision that could not meet daily life needs. This study complied with the Declaration of Helsinki and was approved by the Ethics Committee of Shanghai General Hospital affiliated with Shanghai Jiao Tong University (Ethics Approval No. [2021] 271). All patients signed informed consent forms.

Inclusion criteria: (1) Refractive error $<$ -6.00 D and axial length $>$ 26.5 mm; (2) Confirmed diagnosis of myopic macular degeneration, classified based on the ATN grading system for myopic maculopathy (see 1.2.2), with atrophic lesions of grade A2 or above, tractional lesions of grade T1 or above, or neovascular lesions of grade N1 or above; (3) Met diagnostic criteria for low vision and blindness according to the Chinese Clinical Guidelines for Low Vision Rehabilitation (2021) [1]: second-level low vision: BCVA $\geq$ 0.1 and $<$ 0.3; first-level low vision: BCVA $\geq$ 0.05 and $<$ 0.1; second-level blindness: BCVA $\geq$ 0.02 and $<$ 0.05, or good central vision but small visual field with radius $<$ 10° but $>$ 5° centered on fixation point; first-level blindness: BCVA $<$ 0.02 to light perception, or visual field radius $<$ 5°.

Exclusion criteria: Combined with other fundus diseases unrelated to myopic macular degeneration that would affect ATN grading, including diabetic retinopathy, age-related macular degeneration, retinal vein occlusion, central serous chorioretinopathy, etc.

1.2 Methods

1.2.1 Basic Information Collection Patient demographic information was collected, including age, sex, history of primary ocular diseases (including cataract, glaucoma, corneal disease, fundus disease, etc.), and treatment history.

1.2.2 Ocular Disease and Visual Impairment Assessment After professional ophthalmologists performed slit-lamp examination and fundus examination, distant vision was tested using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart [10]. Best-corrected visual acuity (BCVA) was recorded based on refraction results and included in statistical analysis as logarithm of

the minimum angle of resolution (logMAR), where higher logMAR indicates worse vision. The eye with better corrected vision was defined as the "better eye," while the other eye with worse corrected vision was defined as the "worse eye." Monocular contrast sensitivity (CS) was tested using the Mars contrast sensitivity test chart, and the logarithmic value (logCS) was recorded.

Color fundus photography was captured using the German Zeiss CLARUS 500 ultra-widefield fundus camera. Optical coherence tomography (OCT) of the fundus was performed using the German Heidelberg Spectralis multimodal imaging platform (wavelength 870 nm, scanning speed 40,000 A-scans/second, scanning range 20° × 20°), and subfoveal choroidal thickness was recorded (defined as the vertical distance between Bruch' s membrane and the choroid-sclera interface in the macular foveal region). B-scan images passing through the center of the fovea were selected, reviewed independently by two professional ophthalmologists who identified and measured the thickness, and the average of the two measurements was used as the final result for statistical analysis.

After image review, fundus photography and OCT images were combined to assist disease diagnosis and severity determination. The ATN classification system [11] was used to evaluate three components and their severity in myopic macular degeneration: atrophy (A), traction (T), and neovascularization (N). Specifically, A0 = no myopia-related fundus changes; A1 = tessellated fundus; A2 = diffuse chorioretinal atrophy; A3 = patchy chorioretinal atrophy; A4 = macular atrophy; T0 = no macular schisis; T1 = inner or outer macular schisis; T2 = inner and outer macular schisis; T3 = subfoveal retinal detachment; T4 = full-thickness macular hole; T5 = macular hole retinal detachment; N0 = no neovascular lesions; N1 = lacquer cracks; N2 = active choroidal neovascularization or Fuchs spot.

1.2.3 Quality of Life Questionnaire Administration The Low Vision Quality-of-Life Questionnaire (LVQOL) was used to assess patients' subjective feelings about their current condition. This questionnaire was developed by WOLFFSOHN et al. [12] and later translated, back-translated, and culturally adapted to form the Chinese version of the LVQOL [13], which has high reliability and validity.

The questionnaire comprises four dimensions: distance vision, mobility and light perception (12 items), adjustment ability (4 items), reading and fine work (5 items), and daily living ability (4 items), totaling 25 items related to vision impairment. A Likert scale from 0 to 5 was used, representing the degree of difficulty experienced in daily activities described in each item (0 = extreme difficulty, 1 = very difficult, 2 = considerable difficulty, 3 = some difficulty, 4 = slight difficulty, 5 = no difficulty). The entire questionnaire was administered by trained professionals who read the questions and provided explanations, recording each patient's total score and scores for each dimension. Higher scores indicated less impact from vision impairment.

1.3 Statistical Analysis SPSS 25.0 software was used for statistical analysis. Normally distributed measurement data were expressed as $\bar{x} \pm s$, and comparisons between groups were performed using paired sample t-tests. Ranked data were expressed as constituent ratios, and comparisons between groups were performed using paired sample Wilcoxon rank-sum tests. Pearson correlation analysis was used to analyze the correlation between LVQOL total score and ocular parameters, Spearman rank correlation was used to analyze the correlation between LVQOL total score and ATN grading, stratified regression analysis was used to assess the moderating effect of the worse eye, and a generalized linear regression model was used to further confirm the influencing factors of quality of life. $P < 0.05$ was considered statistically significant.

2. Results

2.1 Patient Characteristics and Vision-Related Quality of Life Status A total of 40 patients (80 eyes) with low vision due to myopic macular degeneration were included, including 8 males (20%) and 32 females (80%), with a mean age of 63.6 ± 9.8 years. Eight patients had previously undergone phacoemulsification and intraocular lens implantation for cataract; no patients had glaucoma or vision-affecting corneal diseases (corneal ulcer, corneal leukoma, etc.). The better eye had significantly lower logMAR values, and significantly higher logCS and choroidal thickness compared to the worse eye ($P < 0.05$). The severity of atrophic lesions and neovascular lesions was significantly higher in the better eye than in the worse eye ($P < 0.05$), while the difference in tractional lesion severity was not statistically significant ($P > 0.05$) .

The total LVQOL score was 2.54 ± 0.51. One-way ANOVA showed that item scores for distance vision, mobility and light perception, and daily living aspects were between 2-3, adjustment ability item scores were between 3-4, and reading and fine work item scores were between 1-2, with statistically significant differences between dimensions ($P < 0.001$) .

2.2 Correlation Between LVQOL Scores and BCVA/CS LVQOL total score and scores for the four dimensions were correlated with logMAR and logCS of both the better and worse eyes. LVQOL total score and scores for distance vision, mobility and light perception, adjustment ability, reading and fine work, and daily living were all negatively correlated with better eye logMAR and positively correlated with better eye logCS ($P < 0.05$). Adjustment ability scores were negatively correlated with worse eye logMAR and positively correlated with worse eye logCS ($P < 0.05$). Reading and fine work scores and total LVQOL score were positively correlated with worse eye logCS ($P < 0.05$) but not correlated with worse eye logMAR ($P > 0.05$). Distance vision, mobility and light perception, and daily living were not correlated with either worse eye logMAR or logCS ($P > 0.05$) .

To further explore the moderating role of the worse eye on the relationship between better eye BCVA and LVQOL scores, hierarchical regression analysis

was performed with LVQOL total score as the dependent variable (assigned as actual value). Model 1 included only better eye logMAR as an independent variable, Model 2 added worse eye logMAR based on Model 1, and Model 3 added the interaction term between the two (both assigned as actual values). Results showed that the individual contribution of worse eye logMAR to LVQOL total score (β = -5.73, P = 0.014) was about 10% of that of better eye BCVA (β = -52.84, P < 0.001), and the interaction between the two logMAR values was significant (β = 8.25, P < 0.001) . The interaction between worse eye CS and better eye CS had no statistically significant effect on LVQOL total score (P = 0.718).

2.3 Correlation Between LVQOL Scores and ATN Grading To investigate the impact of lesion characteristics in the better eye on quality of life in myopic macular degeneration patients, correlation analysis was performed with LVQOL total score as the dependent variable (assigned as actual value) and ATN grading system choroidal thickness as independent variables (assigned as actual values). Results showed that LVQOL total score was positively correlated with choroidal thickness (r = 0.583, P < 0.001) and negatively correlated with atrophic lesion grading (r = -0.827, P < 0.001) and neovascular lesion grading (r = -0.802, P < 0.001). The correlation between LVQOL total score and tractional lesion grading was not statistically significant (r = -0.260, P = 0.105).

2.4 Influencing Factors of LVQOL Scores Based on the predominant influence of the better eye on LVQOL scores, generalized linear model analysis was performed with LVQOL total score as the dependent variable (assigned as actual value) and age, sex, better eye logMAR, better eye logCS, and better eye choroidal thickness as independent variables (sex: male = 1, female = 2; other variables assigned as actual values). Results showed that LVQOL total score was positively correlated with sex (β = 3.93, P = 0.011), better eye logMAR (β = -9.93, P = 0.016), better eye logCS (β = 18.92, P < 0.001), and better eye choroidal thickness (β = 0.08, P = 0.007), but not significantly correlated with age (β = 0, P = 0.941) .

3. Discussion

This study demonstrates that low vision patients with myopic macular degeneration experience multidimensional reductions in vision-related quality of life. Visual function in the better eye is closely related to quality of life, and the severity of atrophic and neovascular lesions also shows some correlation. Sex, better eye BCVA, CS, and choroidal thickness are key factors affecting quality of life. Future treatment strategies should emphasize visual function improvement, structural index monitoring, and comprehensive disease management to enhance patients' daily quality of life.

The impact of visual impairment from myopic macular degeneration varies

across different quality of life dimensions. Patients experience the most severe impairment in reading and fine work, while psychological adjustment is less affected compared to age-related macular degeneration patients who have higher rates of emotional disorders [14]. Myopic macular degeneration patients typically have long disease courses, often beginning with high myopia from a young age that gradually progresses. This long-term adaptation process may enable patients to have more comprehensive self-awareness and better adjustment abilities. In this study, reading and fine work represented the most challenging domain, with over half of patients reporting considerable difficulty. Personalized visual assistive technology and vision adaptation training should become priorities in low vision rehabilitation for myopic macular degeneration patients, improving reading speed and efficiency and enabling effective use of residual vision for fine operations [15-16], thereby enhancing their quality of life and social participation.

The degree to which quality of life in visually impaired patients is affected by the better eye versus worse eye varies by disease type and severity of vision loss. Most studies consider visual function in the better eye as the main factor affecting vision-related quality of life [17-19], while some report that visual function in the worse eye is a predictor of quality of life in glaucoma patients with peripheral vision loss or diabetic retinopathy patients with more symmetric vision loss [20]. FINGER et al. [21] reported that when the better eye has good vision, patients with worse visual function in the worse eye experience significantly lower vision-related quality of life. This study found that better eye BCVA and CS are significantly correlated with LVQOL scores in low vision patients with myopic macular degeneration. Additionally, correlation and moderating effect results showed that as worse eye BCVA increases, the negative impact of better eye BCVA on quality of life in low vision patients is weakened, suggesting that different levels of worse eye BCVA have an interactive effect on the relationship between better eye BCVA and LVQOL total score.

The reason may be that in non-low vision patients, visual impairment in the worse eye increases anxiety about vision loss in the better eye, thereby affecting quality of life. However, in low vision patients where both eyes have severe visual impairment, patients tend to rely more on the better eye for daily activities such as reading, object recognition, and spatial navigation, compensating for the visual system' s dependence on input from the worse eye and thus increasing the better eye' s impact on quality of life. When worse eye logMAR is high, patients may develop various adaptation strategies, such as relying on other senses to compensate for missing visual information or reducing expectations for visual function improvement. This adaptation somewhat reduces the direct impact of better eye BCVA changes on quality of life, though better eye visual function remains the most important factor influencing LVQOL scores. Given the potential inconvenience, economic burden, and risks of medication or surgery faced by low vision patients, treatment decisions should prioritize visual function improvement in the better eye. Protecting and developing residual vision in the better eye is a key measure in low vision diagnosis, treatment, and rehabilitation

[22].

BCVA and CS are crucial in visual function assessment; the former reflects spatial resolution capability of the macular region under high spatial frequency and high contrast conditions, while the latter reflects the visual system' s ability to distinguish different spatial frequencies and contrast levels. Studies have found that in patients with bilateral age-related macular degeneration, CS shows stronger correlation with LVQOL than BCVA [23]. MURAKAMI [24] and OKAMOTO [25] also found in follow-up studies of 23 patients with macular edema secondary to central retinal vein occlusion that improvement in CS, rather than BCVA, was associated with significant quality of life improvement. This study' s results show that female patients with higher better eye logMAR, lower better eye logCS, and thinner choroidal thickness have lower quality of life, with better eye CS having a greater impact on LVQOL than better eye BCVA in low vision patients with myopic macular degeneration. This suggests that CS may be a better measure than BCVA for predicting performance in daily activities, reading, and object recognition in low vision patients, and represents an important target for improvement in low vision rehabilitation strategies. For CS improvement, using sun hats, filters, or applying contrasting colors can help increase target recognition and significantly improve visual quality in low vision patients [26,27]. Additionally, compared with optical aids such as magnifiers and telescopes that primarily enlarge retinal images, electronic visual aids integrate multiple functions including magnification and adjustable contrast, providing more options for visual rehabilitation.

The close relationship between fundus structural indices and vision-related quality of life includes both direct effects of retinal structural changes on visual function [6] and indirect effects on psychological and social life [9]. For pathological myopia, choroidal thinning is a marker of disease progression and is associated with the emergence of various types of myopic macular lesions. CHEN et al. [28] found that thinner macular choroidal thickness is a major risk factor for atrophic and neovascular lesions. WONG et al. [29] reported in a multicenter study that choroidal thinning occurs with increasing severity of myopic macular degeneration, while scleral thickness shows weaker correlation with disease severity, suggesting that progressive choroidal loss may be particularly important in pathogenesis. YE et al. [30] found that both outer retinal and choroidal thicknesses correlate with vision impairment caused by pathological myopia, and this correlation varies with choroidal thickness. This study found that LVQOL total score was positively correlated with choroidal thickness, suggesting that choroidal thickness, as an important characteristic for assessing pathological myopia severity, may indicate greater vision impairment and affect quality of life as it becomes thinner. Additionally, this study found that low vision patients with severe atrophic and neovascular lesions have lower vision-related quality of life, while tractional lesions have less impact. Therefore, rehabilitation strategies for low vision patients with myopic macular degeneration should focus on monitoring the progression of atrophic lesions and treating neovascular lesions, identifying patients who may benefit from anti-vascular endothelial growth fac-

tor therapy as early as possible to reduce the negative impact of neovascular lesions and macular atrophy on visual function and quality of life.

This study has several limitations. First, it focused primarily on LVQOL assessment and BCVA, CS, and imaging features, without comprehensive statistical analysis of additional visual indicators such as visual field and color vision, or demographic factors such as economic status and education level. Second, while LVQOL primarily reflects difficulties encountered in vision-related aspects of low vision patients, its assessment of social limitations and reading ability decline reported by patients is insufficient. Future studies should use targeted scales to more comprehensively evaluate, monitor, and describe the quality of life in low vision patients with myopic macular degeneration.

In summary, this study demonstrates that low vision patients with myopic macular degeneration experience multidimensional reductions in vision-related quality of life. Visual function in the better eye is closely related to quality of life, and the severity of atrophic and neovascular lesions also shows some correlation. Sex, better eye BCVA, CS, and choroidal thickness are key factors affecting quality of life. Future treatment strategies should emphasize visual function improvement, structural index monitoring, and comprehensive disease management to enhance patients' daily quality of life.

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