# Objective Optical Quality and Intraocular Scattering in Myopic Adults

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**Purpose.** To evaluate objective optical quality and intraocular scattering in adults with myopia.

**Methods.** This was a cross-sectional study. Patients between 18 and 40 years of age were recruited from those undergoing routine preoperative examinations prior to myopic refractive surgery. The spherical equivalent refraction (SE) ranged from −14.25 to −0.63 diopters (D). Right eyes of 274 subjects were included for factor analyses: 25 eyes were super-high myopia (SE $<$ −9 D), 88 eyes were high myopia (−6 D $>$ SE $\geq$ −9 D),133 eyes were moderate myopia (−3 D $>$ SE $\geq$ −6 D), and 28 eyes were low myopia (SE $\geq$ −3 D). A double-pass system was used to measure the modulation transfer function cutoff frequency ($MTF_{cutoff}$) and objective scatter index (OSI).

**Results.** Mean $MTF_{cutoff}$ was 32.38 ± 9.73 and 27.61 ± 8.11 cycles per degree (cyc/deg) in the high and super-high myopia groups, significantly lower than 39.92 ± 10.53 and 37.39 ± 8.74 cyc/deg in the low and moderate groups ($P < 0.01$). Mean OSI was 0.89 ± 0.61 and 1.33 ± 0.65 in the high and super-high myopia groups, significantly higher than in the low and moderate groups, 0.50 ± 0.39 and 0.57 ± 0.44 ($P < 0.01$). No significant difference was found between the low myopia and the moderate myopia group in any of the parameters ($P > 0.05$). Other factors such as eye side, sex, and age did not significantly affect optical quality parameters or OSI in this study population ($P > 0.05$).

**Conclusions.** Optical quality and intraocular scattering varied among individuals with myopia. High myopia has more influence on retinal image quality and scattering than moderate and low myopia. Our study also helps to establish $MTF_{cutoff}$ and OSI standards for Chinese refractive surgery candidates.

Keywords: optical quality, intraocular scattering, modulation transfer function, high myopia, refractive surgery

Characteristics of the myopic visual system have been extensively studied. It is well acknowledged that visual acuity and contrast sensitivity decrease with increasing myopia.[1–3] Aberration and scattering are two important factors that affect the human optical quality. Correlations between high-order aberrations and myopia are inconclusive.[4–6] Retinal straylight-related studies, in which a psychophysical method is used to measure the scattering, suggested that the scatter light increases with ocular axial length or myopic spherical equivalent.[7,8] In the present study, another objective and quantitative method based on the double-pass technique, the optical quality analysis system (OQAS), was used to characterize both retinal image quality and intraocular scattering in myopes of different levels. Modulation transfer function (MTF) is a comprehensive indicator for evaluating objective optical quality. The double-pass retinal image system directly computes MTF from the acquired retinal image using Fourier transformation.[9,10] Several simplified indexes have been used in clinical applications, including the MTF cutoff frequency, Strehl ratio in two dimensions (SR), OQAS values (OV) at different contrasts (100%, 20%, and 9%), and the objective scatter index (OSI). The principles behind these indexes and methods of use have been clarified in previous studies.[11–13]

The double-pass system has been shown to produce consistent results,[12,14] with the optical quality of different populations reported across several studies.[13,15] However, in most of the studies, the ocular refraction was limited to those with low to moderate myopia. For example, Martínez-Roda et al.[13] found no correlation between optical quality and spherical equivalent (SE) in young adults with low and moderate myopia, emmetropia, or low hyperopia (SE from –6.00 to +2.00 diopters [D]). So far, few studies have examined optical quality in subjects with a high degree of myopia (SE $<$ –6.00 D). Vilaseca et al.[16] classified a small group of subjects (25 subjects, 50 eyes) with myopia into different groups, depending on optical quality, and found that the low optical quality group (–7.21 ± 1.83 D) had a higher degree of myopia compared to the high optical quality group (–5.96 ± 1.28 D). Although there was no significant SE difference between the groups, this study suggests that individuals with a higher degree of myopia tend to have lower optical quality.

The importance of evaluating visual outcomes following refractive surgery is widely acknowledged. The double-pass

system has demonstrated good repeatability[12,14] and has already been used in optical quality evaluation after corneal refractive surgeries[16–18] and phakic intraocular lens implantation for myopia correction.[19,20] Preoperative optical quality is important as a reference value in evaluating the effects of refractive surgeries. The study by Vilaseca et al.[16] showed a link between changes in optical quality after laser in situ keratomileusis (LASIK) surgery and the patient's preoperative optical quality. Anera et al.[18] found that the SR diminished 3 months after LASIK. Ondategui et al.[17] found that $MTF_{cutoff}$ and SR decreased and OSI increased 3 months after photorefractive keratectomy (PRK) and LASIK surgery. It is reported that higher degrees of myopia have an adverse effect on quality of life.[21] Myopia is a very common condition in China, with a much greater prevalence of high-degree myopia compared to that in Western countries. Most of the patients seeking refractive surgery treatments have had a moderate to high degree of myopia. It was therefore essential that this study evaluate objective optical quality in the high-myopia population. We investigated objective optical quality and intraocular scattering for different levels of myopia in Chinese adults between 18 and 40 years of age.

## Methods

### Subjects

Subjects were recruited from patients undergoing routine preoperative examination prior to myopic refractive surgery in the Eye and Ear Nose and Throat Hospital of Fudan University, Shanghai, China. Patients meeting the following criteria were included: (1) 18 to 40 years of age, (2) a spherical refractive error between −0.5 and −13.5 D and a cylindrical error $\geq$ −3 D, (3) a best corrected visual acuity (BCVA) $\geq$ 0.8 based on the Snellen chart, and (4) having stopped wearing contact lens at least 1 week previously. All the patients underwent detailed ophthalmic examinations, and those with the following were excluded: (1) any eye disease except for myopia or astigmatism, (2) a history of ocular surgery, or (3) any systemic disease. The study enrolled 291 patients (547 eyes), with 274 right and 273 left eyes.

Specific demographic and refractive data of the 274 right eyes of 274 patients are listed in Table 1, with 122 male subjects and 152 females. The mean age of the subjects was 25.73 ± 6.24 years, and mean refraction SE was −5.74 ± 2.38 D. Four subgroups were categorized according to their SE values, with 25 eyes in the super-high myopia group (SHM, SE $<$ −9 D) and 88 eyes in the high myopia group (HM; −6 D $>$ SE $\geq$ −9 D); 133 eyes in the moderate myopia group (MM; −3 D $>$ SE $\geq$ −6 D), and 28 eyes in the low myopia group (LM; SE $\geq$ −3 D).

All study procedures were performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all the subjects. The study was approved by the ethics committee of the Eye and Ear Nose and Throat Hospital of Fudan University, Shanghai, China.

### Objective Optical Quality and Intraocular Scattering Measurement

An optical quality analysis system (OQASII; Visiometrics, Terrassa, Spain), based on the double-pass technique, was used to measure parameters for retinal image quality and intraocular scattering of each eye. All the measurements were conducted in mesopic conditions with a 4.0-mm artificial pupil, operated by an experienced technician. The measurements were always performed first in the right eye; three consecutive measurements were obtained, and the mean value for each parameter was calculated. During the measurements, any spherical refractive error $\geq$ −8.00 D was automatically corrected by the double-pass system. Spherical refractive errors exceeding −8.00 D (the residual spherical error) were corrected with an external lens, as were all cylindrical errors. It was demonstrated in a previous study that no significant difference in ocular optical quality parameters was obtained using a trial spectacle or the built-in modified Thorner optometer for spherical refractive error correction in the OQAS system.[22] We also compared the optical quality measurements between the two methods for spherical refraction correction—external lenses versus the incorporated optometer in the double-pass system—in a small group of low and moderate myopes from 18 to 40 years and found no significant measurement difference between the groups (data not shown). So it is considered that a clean external trial lens with no obvious damage has little impact on optical quality measurements.

Table 1. Demographic and Refractive Data, $n = 274$

| Parameters | Mean | SD | Min | Max |
|---|---|---|---|---|
| Age, y | 25.73 | 6.24 | 18 | 40 |
| Sphere, D | −5.35 | 2.28 | −13.5 | −0.5 |
| Cylinder, D | −0.77 | 0.64 | −3 | 0 |
| SE, D | −5.74 | 2.38 | −14.25 | −0.63 |
| BCVA | 1.06 | 0.13 | 0.8 | 1.5 |
| $MTF_{cutoff}$, cyc/deg | 35.15 | 9.82 | 13.27 | 54.58 |
| SR | 0.20 | 0.06 | 0.08 | 0.39 |
| OV100% | 1.17 | 0.33 | 0.44 | 1.82 |
| OV20% | 1.14 | 0.38 | 0.38 | 2.10 |
| OV9% | 1.14 | 0.39 | 0.38 | 2.38 |
| OSI | 0.74 | 0.57 | 0.07 | 3.15 |

$n$ = number of eyes; SD, standard deviation; Min, minimum value; Max, maximum value.

The double-pass system obtains images from a point-source object reflecting on the retina. The near-infrared light point-source object consists of a laser diode (wavelength, 780 nm) coupled to an optical fiber, and the system directly computes the MTF from the acquired double-pass retinal image through Fourier transformation.[11] The MTF represents the loss of contrast produced by the eye's optics as a function of spatial frequency, which provides information about the overall optical performance of the human eye. Also the OQAS system provides several simpler parameters that are related to the MTF profile to facilitate clinical use: $MTF_{cutoff}$ (cycles per degree, cyc/deg), SR, and OV at different contrasts (100%, 20%, and 9%).

The $MTF_{cutoff}$ for the double-pass instrument is the spatial frequency that corresponds to a 0.01 MTF value, and a cutoff frequency of 30 cyc/deg in contrast sensitivity function usually corresponds to a visual acuity of 20/20. The SR is calculated in two dimensions as the ratio between the area under the MTF curve of the measured eye to that of the aberration-free eye.[12,13] The SR ranges from 0 to 1.0; an SR of 1.0 therefore indicates a perfect optical system. The three OVs (OV100%, OV20%, OV9%) are normalized values of spatial frequencies that correspond to the 0.01, 0.05, and 0.1 MTF values. The three spatial frequencies correspond to optical quality at three contrast conditions that are commonly used in ophthalmologic practice, and the OVs are values normalized to be comparable to standard decimal visual acuity values. For example, OV100% is the $MTF_{cutoff}$ frequency divided by 30 cyc/deg and is directly related to the $MTF_{cutoff}$ and the patient's visual acuity; OV100% higher than 1.0 is associated with high optical quality.[16] In

**Table 2.** Correlation Analysis Between Age, Spherical Equivalent Refraction, and Optical Quality Parameters

| Parameters | *r* for Age | *P* Value | *r* for SE | *P* Value |
|---|---|---|---|---|
| $MTF_{cutoff}$, cyc/deg | −0.01 | 0.87 | 0.38 | <0.01 |
| SR | −0.09 | 0.16 | 0.42 | <0.01 |
| OV100% | −0.01 | 0.88 | 0.38 | <0.01 |
| OV20% | −0.03 | 0.61 | 0.40 | <0.01 |
| OV9% | −0.07 | 0.26 | 0.42 | <0.01 |
| OSI | 0.00 | 0.96 | −0.46 | <0.01 |

*r*, Spearman's correlation coefficient.

general, the higher the $MTF_{cutoff}$, SR, and OV values, the better the ocular optical quality. The system also uses the OSI to quantify intraocular scattered light. The OSI is computed as the ratio of the amount of light within an annular area between 12 and 20 minutes of arc compared to that recorded within 1 minute of arc of the central peak in the acquired double-pass image. In most studies, OSI values close to 1.0 are usually recorded in eyes with low scattering; and usually the higher the OSI value, the greater the intraocular scatter.[13,23]

### Statistical Analysis

Data analysis was performed using Stata statistical software version 9.0 (Stata Corporation, College Station, TX, USA). The distributions of all analyzed variables in this study (demographics, clinical data, and optical quality parameters) were skewed ($P < 0.05$). Wilcoxon rank-sum tests were used to compare parameters between eyes (left/right) and sexes (female/male). Mean $MTF_{cutoff}$ of right eyes was 35.15 ± 9.82 cyc/deg and of left eyes was 34.39 ± 9.44 cyc/deg ($P = 0.25$); mean OSI was 0.74 ± 0.57 in right eyes and 0.77 ± 0.62 in left eyes ($P = 0.74$). No statistical significance was found in any parameters for the values from the right and left eyes, so the data from the right eyes were selected for further analysis. The Kruskal-Wallis test was applied to compare parameters in different myopic degrees (LM, MM, HM, SHM) and different BCVAs (0.8, 0.9, 1.0, 1.2, 1.5). The Scheffe correction was applied to adjust the observed significant level for multiple comparisons if the null hypothesis was rejected. Correlation analysis was used to evaluate the relationship between two continuous variables. The results were considered statistically significant at $P < 0.05$.

## Results

The mean overall $MTF_{cutoff}$ for right eyes of the 274 subjects was 35.15 ± 9.82 cyc/deg; mean SR was 0.20 ± 0.06; mean OV100%, OV20%, and OV9% were 1.17 ± 0.33, 1.14 ± 0.38, and 1.14 ± 0.39, respectively (Table 1); mean OSI was 0.74 ± 0.57. No sex difference was found in all parameters; mean $MTF_{cutoff}$ was 34.24 ± 10.45 cyc/deg in female subjects and 36.28 ± 8.87 cyc/deg in males ($P = 0.18$); mean OSI was 0.81 ± 0.66 in females and 0.64 ± 0.42 in males ($P = 0.13$). The $MTF_{cutoff}$, SR, OVs, and OSI showed no differences related to age ($P > 0.05$) (Table 2). Correlation analysis showed a significant positive relationship between each parameter of optical quality and SE and a significant negative relationship between OSI and SE ($P < 0.01$) (Table 2, Fig. 1).

The parameters for optical quality were significantly lower in the HM and SHM groups than in the LM and MM groups; mean $MTF_{cutoff}$ was 39.92 ± 10.53 cyc/deg for LM, 37.39 ± 8.74 cyc/deg for MM, 32.38 ± 9.73 cyc/deg for HM, and 27.61 ± 8.11 cyc/deg for SHM ($P < 0.01$) (Table 3, Fig. 2). The SR and the OVs showed tendencies similar to the $MTF_{cutoff}$. The OSI was significantly higher in the HM and SHM groups than in the

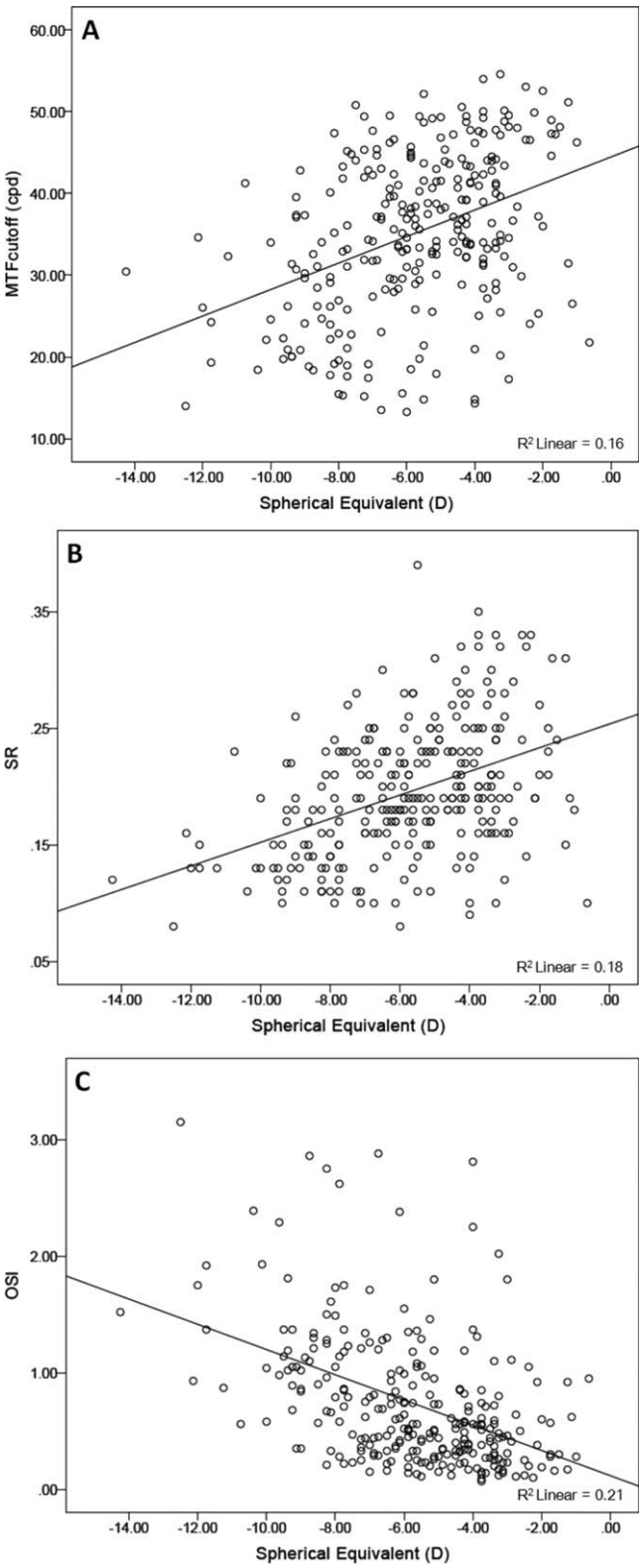


**Figure 1.** Scatter diagrams of $MTF_{cutoff}$ (**A**), SR (**B**), and OSI (**C**) against spherical equivalents demonstrating significant positive correlations between $MTF_{cutoff}$, SR, and myopic refractive errors and negative correlation between OSI and myopic refractive errors ($P < 0.01$). $MTF_{cutoff}$ according to Spearman's correlation coefficient is 0.38; SR according to correlation coefficient is 0.42; OSI according to correlation coefficient is −0.46.

**Table 3.** Mean Optical Quality and Intraocular Scattering in Different Myopic Levels

| | Not High Myopia | | High Myopia | | |
|---|---|---|---|---|---|
| **Parameters** | **LM, $n = 28$** | **MM, $n = 133$** | **HM, $n = 88$** | **SHM, $n = 25$** | ***P* Value** |
| $MTF_{cutoff}$, cyc/deg | 39.92 (10.53) | 37.39 (8.74) | 32.38 (9.73)*† | 27.61 (8.11)*† | <0.01 |
| SR | 0.22 (0.07) | 0.21 (0.06) | 0.18 (0.05)*† | 0.14 (0.05)*† | <0.01 |
| OV100% | 1.33 (0.35) | 1.25 (0.29) | 1.08 (0.32)*† | 0.92 (0.27)*† | <0.01 |
| OV20% | 1.36 (0.44) | 1.23 (0.35) | 1.03 (0.34)*† | 0.83 (0.26)*† | <0.01 |
| OV9% | 1.34 (0.47) | 1.24 (0.37) | 1.01 (0.33)*† | 0.80 (0.25)*† | <0.01 |
| OSI | 0.50 (0.39) | 0.57 (0.44) | 0.89 (0.61)*† | 1.33 (0.65)*†‡ | <0.01 |

Values are displayed as mean (SD).
* Versus LM and of statistical significance ($P < 0.05$).
† Versus MM.
‡ Versus HM.

LM and MM groups; mean OSI was 0.50 ± 0.39 for LM, 0.57 ± 0.44 for MM, 0.89 ± 0.61 for HM, and 1.33 ± 0.65 for SHM ($P < 0.01$) (Table 3). No significant difference was found between LM and MM in any of the parameters ($P > 0.05$). The differences between HM and SHM in SR ($P = 0.06$), OV20% ($P = 0.09$), and OV9% ($P = 0.07$) were of borderline significance. Mean OSI in SHM was significantly higher than that in HM ($P < 0.01$), while no significant difference was found between the two groups in other optical quality parameters.

The mean OVs showed good consistency with BCVA. The parameters for optical quality were significantly lower in eyes with a lower BCVA compared with those with a better BCVA ($P < 0.01$), and the OSI was significantly higher in eyes with a lower BCVA ($P < 0.01$) (Table 4).

## Discussion

The number of refractive surgical procedures undertaken has grown rapidly in China over recent years, with LASIK and PRK remaining the most commonly used surgical techniques for the correction of myopia, and with intraocular lens implantation (ICL) a preferred method to correct super-high-degree myopia. It is essential to improve optical quality evaluation following surgery, especially in high myopic patients. Our study examined optical quality and intraocular scattering in young Chinese adults (18–40 years of age), a population with a large proportion of high myopes, and provides a reliable preoperative reference for myopic patients.

In the present study, objective optical quality and intraocular scattering values were evaluated using a double-pass system. Optical quality was lower and OSI was higher in HM and SHM groups compared to the LM and MM groups. In another study measuring optical quality in myopic chicken models with an objective double-pass technique, the researchers found that optical quality was worse in myopic eyes.[24] The study by Vilaseca et al.[14] involved 10 emmetropes from 20 to 30 years of age with BCVAs better than 1.0; their repeatability data exhibited better optical quality values than in our myopic population, with mean $MTF_{cutoff}$ of 46.00 cyc/deg and mean OSI of 0.32. However, no such correlation has been found in previous studies involving a human population. This might be due to their relative small samples or limited degrees of myopia.[13,16] A study by Martínez-Roda and colleagues[13] showed no relationship between refraction and optical quality, but their study population was composed of subjects with hyperopia, emmetropia, and low/moderate myopia (sphere, +3.00 to –6.00 D), with no high myopia cases included (mean SE, 1.07 ± 1.39 D). Vilaseca et al.[16] classified 25 subjects with myopia (50 eyes) into different groups according to optical quality. The low optical quality group (–7.21 ± 1.83 D) showed a higher degree of myopia than the high optical quality group (–5.96 ± 1.28 D). However, lack of SE difference between the groups might be due to the relatively small sample size (6–18 eyes in each subgroup). The present study had a comparatively large sample size, and all the subjects were myopic. In addition, no difference was found between LM and MM, indicating that high myopia has more influence on optical quality and intraocular scattering.

Optical quality after posterior chamber phakic ICL for MM to SHM (–3.44 to –11.04 D) was evaluated in studies by Kamiya et al.[20] Mean $MTF_{cutoff}$ and OSI were 27.58 ± 9.11 cyc/deg and 1.18 ± 0.53, respectively, after ICL for myopia correction in patients between 18 to 43 years of age, similar to the mean values for SHM in our study. No double-pass data on super-high myopia have been reported, so our results provide a useful reference for studies involving SHM. Saad et al.[12] investigated repeatability of the double-pass system and reported optical quality in four groups, normal or pathological. Our results showed significantly better optical quality and lower scattering than in their cataract group, in which mean $MTF_{cutoff}$ and OSI were 13.3 ± 1.69 and 6.15 ± 0.50 cyc/deg, respectively. In addition, results from the LM and MM groups in our study are close to those for their younger (<30 years) control group, and our results for SHM are close to those for their older (>40 years) control group or post-LASIK surgery group. As suggested

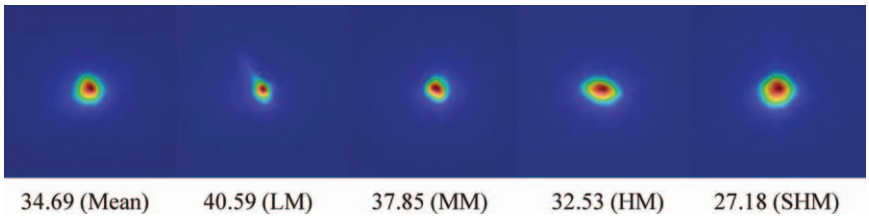


**Figure 2.** Example of double-pass images corresponding to mean values of $MTF_{cutoff}$ (cyc/deg) in all the subjects (mean) and in different myopia groups (LM, MM, HM, SHM). The MTF values are computed from the retinal images recorded after a point-source double pass through the ocular media and retinal reflection.

Table 4. Mean Spherical Equivalent Refraction, Optical Quality, and Intraocular Scattering in Different BCVAs

| BCVA (*n*) | 0.8 (13) | 0.9 (11) | 1.0 (159) | 1.2 (80) | 1.5 (11) | *P* Value |
|---|---|---|---|---|---|---|
| SE, D | −8.02 (3.21) | −7.36 (2.45) | −5.92 (2.35) | −4.80 (1.90) | −4.29 (1.97) | <0.01 |
| $MTF_{cutoff}$, cyc/deg | 25.53 (7.41) | 27.93 (8.87) | 33.89 (9.20) | 38.25 (9.23) | 39.48 (8.27) | <0.01 |
| SR | 0.14 (0.04) | 0.15 (0.03) | 0.19 (0.05) | 0.22 (0.06) | 0.22 (0.06) | <0.01 |
| OV100%, | 0.85 (0.25) | 0.93 (0.30) | 1.13 (0.31) | 1.28 (0.31) | 1.32 (0.28) | <0.01 |
| OV20%, | 0.79 (0.26) | 0.85 (0.28) | 1.09 (0.35) | 1.29 (0.38) | 1.31 (0.38) | <0.01 |
| OV9% | 0.77 (0.28) | 0.80 (0.22) | 1.08 (0.36) | 1.30 (0.42) | 1.34 (0.41) | <0.01 |
| OSI | 1.49 (0.75) | 1.37 (0.73) | 0.77 (0.56) | 0.56 (0.48) | 0.49 (0.25) | <0.01 |

Values are displayed as mean (SD).

in the study by Saad et al.,[12] a wide interval exists between the normal and pathologic thresholds for OSI measurements; this could explain the relative large variability in our study. Artal et al.[23] measured OSI in patients diagnosed with cataract (grades NO2, NO3, and NO4) according to the Lens Opacities Classification System. Average values of OSI were 3.0 ± 1.0 for the NO2 group and 9.0 ± 3.0 for the NO4 group, much higher than the mean OSI in our study. The above comparisons suggest that, although the optical quality and scattering changes with myopic diopters are of great significance in our study, they are still within normal ranges. The effects of refractive error on MTF and OSI appeared much smaller than that of crystalline lens opacity.

There have been studies of objective quality and intraocular scattering in healthy adults in a number of countries, but data in China are lacking. Compared to the results reported by Martínez-Roda et al.[13] in 178 healthy young adults, the optical quality is lower and OSI is higher in our study; there are a number of possible reasons for the differences. Firstly, Martínez-Roda's study used an inclusion criterion requiring normal mesopic contrast sensitivity, and this may have resulted in a higher optical quality level. Secondly, the degree of myopia is much higher in our study compared to Martínez-Roda's, and this, combined with our findings that SE had important effects on optical quality, indicates that refraction disparity is the main cause of the optical quality differences seen between the two studies. Kamiya et al.[15] reported on a study of 100 healthy adults from 20 to 69 years of age; their optical quality was lower and intraocular scattering higher than found in our study. Age difference is considered to be the main cause, as our subjects were much younger (18–40 years). Thus it is suggested that our study can be assumed to reasonably represent retinal image quality and intraocular scattering in young myopic Chinese adults.

Previous studies have suggested that intraocular aberration and scattering increase with age (mainly due to lens opacity) while retinal optical quality decreases. Guirao et al.[25] used measures of MTF to evaluate the retinal image quality in different age groups. They found that with age, aberration increased and contrast sensitivity decreased. Kamiya et al.[15] studied a group of adults between the ages of 20 and 69 and found that $MTF_{cutoff}$ and SR decreased significantly and OSI increased, also significantly, with advancing age. We found no relationship between age and any parameter in our study, which may be due to our age range (18–40 years). Within this age range, changes in the refractive media, for example, the lens and vitreous opacity, may be so small that their influence on optical quality and intraocular scattering is negligible. This indicates that optical quality and intraocular scattering are stable in 18- to 40-year-old adults. Similarly, Hennelly et al.[26] found that both the increase in straylight and the decrease in contrast sensitivity with age accelerated after age 45. The OSI has been used in previous studies to rank and classify cataract patients; in general, OSI increases with the degree of lens opacity, and young, normal eyes usually have an OSI below 1.0.[23] Mean OSI was 0.75 in our study, suggesting that the average refractive media opacity (mainly caused by the lens) was low in the study population.

A limitation of the present study is that the OSI acquired by the double-pass system shows intraocular scattering at a small angle, which reflects just a part of the scattering under natural viewing conditions. We considered that this limitation is not highly relevant to comparison of retinal image quality and scattering among different myopic groups. The double-pass system provided detailed information about optical quality, which was highly consistent with the visual function in myopes of different levels.

In conclusion, optical quality and intraocular scattering varied among individuals with myopia. The MTF is lower and intraocular scattering is higher in cases of high myopia compared to low and moderate myopia, and further study is needed to identify the mechanism behind this phenomenon. Other factors, such as age, sex, and eye side (right/left), were not found to affect the test parameters in our healthy young adult myopic study population. In addition, our study helps to establish optical quality and objective intraocular scattering standards for Chinese refractive surgery candidates.

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