A comparison of vision-related quality of life between Defocus Incorporated Soft Contact (DISC) lenses and single-vision spectacles in Chinese children

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1. Introduction

There is an epidemic of myopia in children worldwide in recent years, particularly in some developed countries of east and southeast Asia [1–4]. Because high myopia may result in severe pathological changes and consequent visual impairment, it is urgent and necessary to take measures to prevent the progression of myopia in this susceptible population. Various interventions have proved to be effective in myopic control for children [5–7]. However, improper corrections could lead to poor vision-related quality of life (VRQoL), manifested as reduced visual performance, limitations in daily life activities, and decreased life satisfaction. Therefore, the VRQoL should be also focused upon to comprehensively evaluate the visual performance and subjective acceptance of these approaches.

Some standardized questionnaires have been widely used to evaluate the VRQoL in clinical research. The Pediatric Refractive Error Profile (PREP) questionnaire has been specifically designed to evaluate VRQoL in children with refractive error [8,9]. The PREP 2, an updated version of PREP, exhibits good reliability and validity, and could be used as a significant means of quantifying the visual performance and satisfaction levels between various refractive corrections [10–12]. Some studies compare the VRQoL scores in children wearing soft contact lenses (CLs) and single-vision spectacles, and the results reveal that participants with soft CLs report a better VRQoL, especially in the scales of appearance, activities and satisfaction with correction [13–15]. Myopic children wearing orthokeratology (OK) contact lenses also
report significant improvement in the VRQoL when compared to those wearing single-vision spectacles for all survey scales, except for handling and near vision [16].

Recent studies have indicated that the bifocal CLs could effectively retard myopia progression in children compared with single-vision spectacles [3,17–20]. However, few studies have focused on the visual performance and VRQoL in children wearing these lenses. One previous study indicated that Spanish children wearing MiSight CLs, a bifocal designed soft CLs, significantly improve VRQoL scores at 12- and 24-month follow-up visits, as regard appearance, satisfaction, activities, handling, peer perceptions, and the overall score in comparison with single-vision spectacles wear [21].

With the dramatically growing incidence of myopia in at-risk child populations in China, parents are apparently worried and tend to use various approaches to control myopia progression. Low-concentration atropine eye drops have not been officially approved for myopia control by the Chinese Food and Drug Administration [22]. Some specially designed lenses are popular among children in China, for example, bifocal soft CLs, OK contact lenses and bifocal spectacles. However, OK contact lenses are only officially approved for those no younger than eight years old in China, and are often provided to mild to moderate myopic children [23]. Meanwhile, many children or their parents tend to choose contact lenses because of their advantages for activities such as sports or dancing and prefer their appearance compared to spectacles [14,15]. Therefore, bifocal soft CLs are an effective and distinctive choice for myopia control in China. The Defocus Incorporated Soft Contact (DISC) lens is a bifocal soft CL with a concentric ring design, comprised of a correction zone in the center and alternating treatment and correction zones extending towards the periphery. It is intended to simultaneously generate myopic retinal defocus and maintain clear vision [19]. DISC lenses have become increasingly popular for myopia control in China in recent years. However, previous studies have not investigated the vision-related quality of life among Chinese children wearing this bifocal CL.

Therefore, the aim of this study was to compare the VRQoL between children wearing DISC lenses and single-vision spectacles in a sample of Chinese children using the Chinese version of the PREP 2 questionnaire, in order to evaluate the visual performance and subjective acceptance of this bifocal designed CL treatment.

2. Materials and methods

2.1. Participants

This was a retrospective cross-sectional study. Chinese participants aged 7 to 12 years, with myopia from –4.00 to –0.75 D, astigmatism < 1.50 D, and monocular best-corrected visual acuity (BCVA) of 0.0 or better, participated in the study. All participants had already been wearing DISC lenses or single-vision spectacles for the last 6 to 18 months and had no systemic or ocular disease. Participants were recruited when they came back for the follow-up visit in the out-patient clinic of the Tianjin Medical University Eye Hospital, China.

In the current study, the DISC lenses were bifocal and concentric designed soft CLs, consisting of a central correction zone to correct the refractive error, and a series of surrounding treatment and correction zones extending to the periphery, which could result in 3.00 diopeters of myopic retinal defocus. The contact lenses were made from hydroxyethyl methacrylate, with 55 % water content, diameter of 14.2 mm, and base curve of 8.6 mm.

The protocol of the study was reviewed and approved by the ethics committee of the Tianjin Medical University Eye Hospital, China, following the tenets of the Declaration of Helsinki. After a verbal explanation of the purpose and possible risks of the study, both the children and their parents provided informed consent to take part in the study.

2.2. Measurements

All participants were required to complete the Chinese version of the PREP 2 questionnaire before ocular examination. BCVA were obtained with the trial frame and recorded as the logarithm of the minimal angle of resolution (LogMAR). Refractive error was measured by cycloplegic subjective refraction using 1.0 % tropicamide drops. The demographic characteristics and duration of lens wearing was also recorded.

The Chinese version of the PREP 2 questionnaire was translated according to standardized procedure and showed good acceptability, reliability, and validity [12]. It consisted of 7 scales: vision, symptoms, appearance, activities, handling, peer perception, and the overall score, and each scale contains 8 statements [12]. The answers of each statement consist of “strongly disagree,” “disagree,” “neutral,” “agree,” or “strongly agree,” with raw scores from 1 (negative) to 5 (positive) accordingly. The final scores were recorded by subtracting one from the raw score and multiplying by 25, and scaled from 0 (poor visual quality of life) to 100 (good visual quality of life). All participants were requested to read and complete all the 56 questions carefully, and choose only one answer for each question.

The PREP 2 questionnaire was administered by a researcher who did not participate in the data processing. The children were asked to answer the questionnaire independently, and their parents could not give any suggestions and comments. If the children had difficulties completing the survey, the researcher could read and explain the questions to the participants.

2.3. Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) (version 26; IBM, Armonk, NY, USA). Kolmogorov-Smirnov tests were used to determine the normality of data. Mean and SD were reported for normally distributed data, while median, range, skewness, and kurtosis were reported for non-normally distributed data. Independent t-test and Mann-Whitney test were performed for normally and non-normally distributed data, respectively. A Chi-Square test was used for gender comparison. A generalized linear model (GLM) was fitted to assess variables associated with the PREP 2 score. The outcome was the score of each of the 7 scales. The predictors included treatment (DISC lenses vs Single-vision spectacles) and gender as categorical variables, and three continuous variables, i.e., the participant’s age, duration of lens wear, and spherical equivalent refractive error. A p-value of <0.05 was defined as statistically significant.

3. Results

A total of 110 participants were recruited for the study. Fifty-four children (49.1%) were allocated to the DISC group and 56 (50.9%) to the single-vision spectacles group according to the correction modalities. All the participants completed the Chinese version of the PREP 2 questionnaire and ocular examination. There were no statistically significant differences in any of the baseline demographics, refractive data, BCVA, and duration of lens wearing between the two groups (P > 0.05) (Table 1).

The observed PREP 2 scores for the DISC and single-vision spectacles groups are provided in Table 2. Five out of 7 scales of the differences in scores between the two groups were statistically significant (all P < 0.05), except for symptoms and handling (P = 0.199, 0.815, respectively). Participants wearing DISC lenses showed scores for vision, appearance, activities, peer perception, and overall that were significantly higher than those wearing single-vision spectacles (all P < 0.05). The improvement of vision-related quality of life in the DISC group was mainly represented in appearance and activities.

Results of the Generalized linear model indicated that sex, BCVA, spherical equivalent, and duration of lens wear did not affect the score in any PREP 2 scales, while treatment and age had statistically significant
Table 1
Characteristics of demographic and ocular data for participants.

<table>
<thead>
<tr>
<th></th>
<th>DISC group</th>
<th>single-vision spectacles group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs*</td>
<td>9 (7-12)</td>
<td>9 (7-12)</td>
<td>0.822</td>
</tr>
<tr>
<td>Gender, male/female**</td>
<td>25/29</td>
<td>28/28</td>
<td>0.698</td>
</tr>
<tr>
<td>SE for right eye, D**</td>
<td>-2.42 ± 1.07</td>
<td>-2.56 ± 1.05</td>
<td>0.486</td>
</tr>
<tr>
<td>SE for left eye, D**</td>
<td>2.45 ± 1.05</td>
<td>-2.47 ± 1.04</td>
<td>0.886</td>
</tr>
<tr>
<td>BCVA, LogMAR*</td>
<td>0.00</td>
<td>0.00 (-0.20-0.00)</td>
<td>0.742</td>
</tr>
<tr>
<td>Duration of wearing lens, months*</td>
<td>10 (6-18)</td>
<td>12 (6-18)</td>
<td>0.203</td>
</tr>
</tbody>
</table>

SE, spherical equivalent; D, diopters; BCVA, best-corrected visual acuity; LogMAR, the logarithm of the minimal angle of resolution. Data are presented as median (range) for Age, BCVA and Duration of wearing lens, and as Mean ± SD for SE. *Mann-Whitney, **Independent t-test, ***Chi-Square test.

single-vision spectacles.

Table 2
Comparison of PREP scale scores between the DISC and single-vision spectacles group.

<table>
<thead>
<tr>
<th></th>
<th>DISC group</th>
<th>single-vision spectacles group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>78.13 (50-100), -0.31/ -0.13</td>
<td>65.63 (50-93.75), 0.31/ -0.03</td>
<td>&lt;</td>
</tr>
<tr>
<td>Symptoms</td>
<td>71.88 (28.13-96.88), -0.97/0.12</td>
<td>71.88 (28.13-93.75), 0.07/0.34</td>
<td>0.199</td>
</tr>
<tr>
<td>Appearance</td>
<td>87.5 (56.25-100), 0.59/0.15</td>
<td>67.19 (37.5-93.75), 0.21/0.30</td>
<td>&lt;</td>
</tr>
<tr>
<td>Activities</td>
<td>75 (37.5-96.88), -1.00/2.76</td>
<td>59.38 (9.38-81.25), -0.94/0.96</td>
<td>&lt;</td>
</tr>
<tr>
<td>Handling</td>
<td>68.75 (37.5-100), 0.101/0.06</td>
<td>73.44 (40.63-90.63), -0.49/0.46</td>
<td>0.815</td>
</tr>
<tr>
<td>Peer perceptions</td>
<td>79.69 (43.75-100), -0.87/0.59</td>
<td>68.75 (28.13-96.88), -0.54/0.21</td>
<td>&lt;</td>
</tr>
<tr>
<td>Overall</td>
<td>78.13 (46.88-100), -0.68/0.04</td>
<td>65.63 (37.5-100), 0.30/1.06</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Data are presented as median (range), skewness/kurtosis and p-values represent comparison between the DISC and single-vision spectacles group (Mann-Whitney test).

effects on the scores of at least one of the scales. There were no significant interactions between treatment and age for six scales, except for activities. Therefore, the models for these scales fitted with main effects are shown in Table 3.

The results indicated that the PREP 2 score adjusted for sex, spherical equivalent, BCVA, durations of lens wear, and interactions were significantly higher in the DISC group than the single-vision spectacles group by about 9.1 points for the vision scale (P < 0.001). The scores also increased by about 3.6 points with every additional year of age (P < 0.001).

The score was about 12.6 points higher for participants wearing contact lenses than spectacles in the peer perception scale (P < 0.001). For appearance and overall PREP 2 scales, the scores were significantly higher for DISC lenses wearers than single-vision spectacles wearers by about 17.0 and 10.5 points, respectively (both P < 0.001). Meanwhile, there was an age effect for these two scales regardless of treatment group, with about 2.7 points and 3.6 points higher scores for each additional year of age, respectively (both P < 0.001).

As regard scales of symptoms and handling, the scores were not significantly different for DISC lenses wearers compared to spectacles wearers (P = 0.089, P = 0.837, respectively) after adjusting for sex, spherical equivalent, BCVA, durations of lens wear, and interactions. But the scores increased by about 2.3 points for symptoms scale (P = 0.001) and 6.7 points (P < 0.001) for handling scale with every increased year of age.

The interaction between treatment and age was statistically significant for the activities scale (P < 0.05). The scores for the activities scale were significantly higher in the DISC group than single-vision spectacles group, and the differences were greater for the older participants.

4. Discussion

The results of this study showed that Chinese children wearing DISC lenses reported better vision-related quality of life compared with those wearing single vision spectacles for most of the survey scales, especially in the areas of appearance, peer perception and activities. These findings could be attributed to the improvement of cosmetic appearance and the convenience of participating in activities provided by DISC lenses in comparison to spectacles.

With regards to the visual performance scale, better vision was reported with DISC lenses in this study, despite of the fact that there was no significant difference in BCVA between the two groups. This may reflect the observation, reported by several studies, that visual acuity is an unsatisfactory indicator of visual performance, and that subjective measures offer better sensitivity [24–26]. Nevertheless, reduced visual acuity and stability [27], or worse near vision [21], have been reported when wearing progressive or bifocal contact lenses, compared to single-vision spectacles, while other studies failed to find any significant difference for near vision [13,28]. These variable outcomes may be due to differences in the optical design of the contact lens, or other factors, such as misalignment with the pupil center.

There was no significant difference in daytime symptoms between the two groups in the current study. The results were similar to a previous report showing that symptoms did not differ between children wearing bifocal CLs and single-vision spectacles at 24 months follow-up, despite being significantly higher with the CLs at 12 months [21]. Other studies have reported a range of visual complications with bifocal and multifocal contact lens including positive dysphotopsia, altered contrast sensitivity, light disturbance, and poorer visual comfort scores compared to single-vision CLs [29,30]. Orthokeratology, however, is associated with fewer symptoms of dryness, itching, and burning compared to either soft CLs [31,32] or single-vision spectacles [16], perhaps because wear is limited to the hours of sleep.

It was noted from the symptom scales in the current study that scores increased by about 2.3 points with every additional year of age, regardless of different treatment. Walline et al. reported a similar improvement in older participants, speculating that better visual-related quality of life may be more obvious after ten years of age [15]. Clinical experience suggests that as children get older, they are able to avoid habits such as eye rubbing, and become less reactive to uncomfortable symptoms. These factors may be contributing to the age-related differences seen in the data.

Table 3
Modeling of PREP 2 scales without significant interactions.

<table>
<thead>
<tr>
<th>Effect of treatment(95 %CI)</th>
<th>P</th>
<th>Age (increased per year) (95 %CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>9.15 (5.92-12.38)</td>
<td>&lt;0.001</td>
<td>3.59 (2.57-4.61)</td>
</tr>
<tr>
<td>Symptoms</td>
<td>3.83 (-0.59-8.24)</td>
<td>0.089</td>
<td>2.31 (0.91-3.70)</td>
</tr>
<tr>
<td>Appearance</td>
<td>17.01 (12.83-21.18)</td>
<td>&lt;0.001</td>
<td>2.77 (1.45-4.09)</td>
</tr>
<tr>
<td>Handling</td>
<td>0.21 (-1.82-2.24)</td>
<td>0.857</td>
<td>6.70 (6.06-7.34)</td>
</tr>
<tr>
<td>Peer perceptions</td>
<td>12.63 (7.44-17.82)</td>
<td>&lt;0.001</td>
<td>1.48 (-0.16-3.12)</td>
</tr>
<tr>
<td>Overall</td>
<td>10.49 (6.83-14.15)</td>
<td>&lt;0.001</td>
<td>3.65 (2.50-4.81)</td>
</tr>
</tbody>
</table>
The better performance on appearance, peer perception, activities and overall scores with DISC lenses in comparison with single-vision spectacles agreed with one previous study [21], and the improvements were greater in older children for the appearance and overall scores. Another study [14] using the Self-Perception Profile for Children, included physical appearance, athletic competence, and peer interactions components, and while this is a different kind of questionnaire to that used in the current study, the results were similar in finding advantages for contact lenses over spectacle. Likewise, improvements on these scales with OK CLs were shown by Yang et al. [28], and Santodomingo et al. [16] Presumably, it is the perceived enhancement of appearance and the convenience of engaging in activities without spectacles during the daytime that drives these outcomes. In contrast, Garcia et al. reported that the bifocal designed soft CLs worsened the satisfaction and psychometric visual-related quality compared to a single-vision CLs in the same material [30]. However, this assessment was made in adults, after only 25 min of wear, in dim-light conditions, which may explain the different results compared to the current study. Overall, it appears that contact lenses provide good visual performance and increase satisfaction with recreational activities and cosmetic appearance, especially among older children who are likely to pay more attention to these factors.

With regards to scales of handling, no significant differences were found between children wearing DSC lenses and single-vision spectacles, which disagreed with previous studies. Pomeda et al. surprisingly found that the rated score of handling with CLs was higher than spectacles in children, and they assumed the reason was the strong desire to use contact lenses for vision correction and enjoy the perceived convenience they provided [21]. A different study found lower handling scores with OK CLs than for spectacles; [28] a result which, while children and adolescents are reported to be competent and capable of independently managing contact lenses of all types (soft, daily disposable, rigid gas permeable and OK) [15,21,33–36], might be attributed to the strict care procedures required to maintain safety and avoid complications during wear [37]. Certainly, in the present study, enrolled participants wore DISC for 6 months without significant issues and handling scores improved by about 6.7 points per year of age, so it may not be so surprising that performance was not different between the two groups.

The current study had a retrospective design, and a prospective investigation would be preferable in future, to reduce the effects of recall bias. Since all the children wore their CLs or spectacles for 6–18 months and the visual-related quality of life stabilizes after 3 months [10], the current results are likely to reflect real-world VRQoL responses. On the other hand, visual performance among children with high myopia may differ from those with low to moderate myopia [38], so it would be useful to compare between these levels. Unfortunately, access to sufficient numbers of children with high myopia, who are wearing DISC lenses, was limited in this case, but this remains an interesting avenue for further study.

In conclusion, DISC lenses wear significantly improved the vision-related quality of life in Chinese children, compared with single-vision spectacles wear, for most of the survey scales, especially in the areas of appearance, peer perception and activities. The benefits provided by DISC lenses beyond efficacy in the retardation of myopia contribute to greater satisfaction than with single-vision spectacles for myopic children.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References


