Correcting progressive myopia with bifocal contact lenses with central zone for distant vision: changes in accommodation and axial length (a preliminary report)

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Purpose — to assess the state of accommodation and the dynamics of changes of ocular axial length in patients with progressive myopia who use bifocal soft contact lenses (BFSCLs). Material and methods. The main and control groups consisted of 50 children (100 eyes) each. Patients of the main group used BFSCLs with distance-oriented central zone and added power of 4 D on the periphery. Patients of the control group were corrected with spherical soft contact lenses (SSCLs). Baseline measurements included amplitude of accommodation (AA), positive relative accommodation (PRA) and the length of anterior-posterior axis of the eye. All patients were examined before wearing SCLs and every 3 months during the entire period of observation lasting 9 to 12 months. Results. Correction of myopia with contact lenses is accompanied by the increase of AA and PRA. The users of BFSCLs with distance-oriented central zone and added power of 4 D on the periphery, which induces myopic peripheral defocus, had their accommodative function normalize much faster than the patients wearing SSCLs. The average increase in the ocular axial length in the BFSCLs group appeared to be significantly smaller than in the SSCLs group (0.11 and 0.58 D, respectively), which can be attributed to the simultaneous formation of the central focus and induced peripheral myopic defocus.

Keywords: progressive myopia, bifocal contact lenses, accommodation, axial length of the eye, peripheral myopic defocus.

Myopia is the most common refractive error in the world. Its potential complications (central and peripheral retinal dystrophy, retinal detachment, glaucoma, etc.) had been found to correlate with significant increase of eye dimensions and the myopia level: lengthening of the anterior-posterior (A-P) axis of the eye from 24–26 to 30 mm and more correlated with 6-fold increased risks of complications [1]. This makes the search for effective non-invasive methods of prevention (control) of myopia progression a highly relevant task.

In recent years, attempts to stabilize axial length (and, consequently, the level of myopia) involved various methods of manipulating peripheral defocus and accommodation. For example, the stabilizing effect of orthokeratology correction is associated mainly with induction of peripheral myopic defocus on the retina, which can slow its growth [2].

Another factor that can influence myopia progression is the accommodation apparatus or, more precisely, its various disorders accompanied by decrease in the amplitude of accommodation (AA) and positive relative accommodation (PRA), delay in accommodation response, comitant esophoria [3].

Recently obtained data suggests the possibility of using soft contact lenses (SCLs) of bi- and multifocal design with peripheral add power of 2.5 Diopters and higher for management of myopia [4–7]. However, the mechanism by which this method provides stabilization has not been sufficiently studied. Considering the optical design of these contact lenses (simultaneous presence of specific zones for near and distant vision), it may be possible that the stabilizing effect of correction is realized through action on the accommodation apparatus.

The purpose of the present study is to assess the state of accommodation and the changes of axial length of the eye in patients who use bifocal SCLs (BFSCLs).

Material and methods

The study included 100 patients (200 eyes) with bilateral progressing myopia (yearly gradient of progression was between 0.74 and 0.92 Diopters per year) — the main and the control groups each consisting of 50 patients (100 eyes) with mean age of 10.24±1.92 and 13.56±1.26 years, respectively. Additionally, each group was subdivided into two subgroups including patients with low and moderate myopia (M1 and C1; M2 and C2, respectively). Presence of astigmatism or anisometropia of 1.0 Diopters and higher in refraction was the criteria for exclusion from the study.

Correction of myopia in the main group was done with BFSCLs with central area designed for distant vision and add power of 4 Diopters for periphery (Russian patent no. 2657854 “Method of treating progressing myopia and lenses for treating progressive myopia” registered on 13.01.2017). Contact lenses of this design have central optical zone that provides correction of central defocus, while their periphery is meant to change peripheral refraction
Mean axial length (μm, mm) at various observation times

<table>
<thead>
<tr>
<th>Study group</th>
<th>Initial axial length</th>
<th>After 6 months</th>
<th>Δ 0–6 months</th>
<th>p</th>
<th>After 12 months</th>
<th>Δ 0–12 months</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>24.65±0.19</td>
<td>24.71±0.21</td>
<td>0.06</td>
<td>&gt;0.05</td>
<td>24.76±0.18</td>
<td>0.11</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>K1</td>
<td>24.58±0.21</td>
<td>24.96±0.21</td>
<td>0.38</td>
<td>&gt;0.05</td>
<td>25.12±0.14</td>
<td>0.54</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>O2</td>
<td>25.21±0.23</td>
<td>25.29±0.21</td>
<td>0.08</td>
<td>&gt;0.05</td>
<td>25.32±0.21</td>
<td>0.11</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>K2</td>
<td>25.19±0.19</td>
<td>25.59±0.22</td>
<td>0.31</td>
<td>&gt;0.05</td>
<td>25.86±0.22</td>
<td>0.58</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
Fig. 1. Graphic representation of AA (a) and RPA (b) dynamics in different groups. Horizontal axis — the parameters dynamics (Diopters), vertical axis — observation time (months).

of either central focus, or “induced” myopic peripheral defocus, formation of which was indirectly confirmed by patients’ complaints about blurring peripheral vision when they looked into distance during the early periods of BF-SCLs usage. It is possible that fast adaptation to the phenomenon is explained by the relatively well-known phenomenon of reduced sensitivity to defocusing of the image in myopia [9]. Improvement of clinical refraction and eye elongation may be accompanied by the change in peripheral defocus [10].

Currently there is no consensus on the mechanism of stabilizing action that myopic peripheral defocus has on myopia progression. One possible explanation involves dopaminergic neurotransmitter system realized through amacrine cells of inner plexiform layer of the retina: formation of peripheral defocus is the initiation factor for this system. Dopamine, known to increase nerve conduction and enhance metabolic activity in the choroid, thus stimulates synthesis of proteoglycans, which in turn improve biomechanical characteristics of the sclera [11].

Conclusions

1. Correction of myopia with contact lenses is accompanied by increased amplitude of accommodation and positive relative accommodation. Usage of bifocal contact lenses with central zone for distance and add power of 4.0 Diopters for periphery, which induce myopic peripheral
defocus, normalizes initially diminished accommodative function in less time than spherical soft contact lenses.

2. During the one-year observation period, mean increase of the axial length when wearing bifocal soft contact lenses turned out to be significantly less prominent than with prescribed spherical lenses (0.11 versus 0.58 Dipters, respectively), which may be caused by simultaneous formation of central defocus and induced peripheral myopic defocus.

**Author contributions:**
Study conception and design: S.A., A.M.
Acquisition and processing of data: A.M., A.E.
Statistical analysis: A.E.
Drafting of manuscript: A.M.
Critical revision: S.A., A.M.

The authors declare that there are no conflicts of interest.

**ЛИТЕРАТУРА/REFERENCES**