Contact Lens and Anterior Eye xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Contact Lens and Anterior Eye

journal homepage: www.elsevier.com/locate/clae

Near binocular visual function in young adult orthokeratology versus soft contact lens wearers

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ARTICLE INFO

Article history:
Received 11 October 2016
Received in revised form 5 December 2016
Accepted 10 January 2017

Keywords:
Accommodation
Binocular vision
Contact lenses
Myopia
Orthokeratology
Heterophoria

ABSTRACT

Purpose: To compare near point binocular vision function of young adult myopes wearing orthokeratology (OK) lenses to matched single vision soft disposable contact lens (SCL) wearers.
Methods: A retrospective clinical record analysis of all OK wearers (18–30 years) presenting over an 18 month period was undertaken. Data was extracted for 17 OK wearers, with 17 SCL wearers matched for age, refractive error and duration of contact lens wear. Binocular vision data included horizontal phoria (phoria), horizontal base-in (BIFR) and base-out fusional reserves (BOFR) and accommodation accuracy (AA).
Results: The OK group was 25.8 ± 3.2 years, with a duration of wear of 45.7 ± 25 months and refractive error of R −2.09 ± 1.23D, L −2.00 ± 1.35D. Compared to matched SCL wearers the OK group were significantly more exophoric (OK −2.05 ± 2.38Δ; SCL 0.00 ± 1.46Δ, p = 0.005) and had better accommodation accuracy (OK 0.97 ± 0.33D; SCL 1.28 ± 0.32D, p = 0.009). BIFR and BOFR were not different in the two groups. Frequency histograms showed that more SCL wearers had high lags of accommodation (AA ≥ 1.50D: 8 SCL,2 OK) and esophoria (≥1Δ: 5 SCL,1 OK) than OK wearers. A positive correlation was found between refraction and phoria in the SCL group (r = 0.521, p = 0.032).
Conclusion: Young adult myopes wearing OK lenses display more exophoria and lower accommodative lags at near compared to matched single vision SCL wearers. Young adult myopes with specific binocular vision disorders may benefit from OK wear in comparison to single vision SCL wear. This has relevance to both the visual acceptance of OK lenses and in managing risk factors for myopia progression.

1. Introduction

Orthokeratology (OK) is a specialty contact lens modality used for correction of low to moderate degrees of myopia [1]. In recent years, attention has turned to the use of OK lenses to slow the progression of myopia, with recent meta-analyses of several controlled studies indicating a mean reduction in axial elongation of 45% over two to five years [2,3]. This makes the modality particularly attractive for practitioners prescribing to children [4] and young adults with progressive myopia. OK is also appealing to those with active lifestyles and/or contact lens related dry eye who wish to be independent of spectacle or contact lens correction during the day.

When compared to spectacles, the myopic single vision soft contact lens (SCL) wearer must increase accommodation and convergence effort at near [5,6], which has the potential to lead to symptoms of headache, blurred vision and asthenopia. The latter can manifest as tired, irritated and red eyes [7] which can adversely impact contact lens wear. For the young adult progressing myope, increased binocular demand with contact lens wear could exacerbate existing binocular vision anomalies associated with myopia progression – this group have demonstrated more near esophoria, increased accommodative lag, and greater variability in accommodative responses with closer near demands when compared to stable myopes and emmetropes [7–10]. Whether OK is fitted to either stable or progressing young adult myopes, it is critical to understand the effect on binocular vision function. Recent data indicates an improvement in amplitude of accommodation in children wearing OK, and a greater myopia controlling effect in those with a below-average baseline amplitude of accommodation [11].

Clinical evaluation of near binocular vision function includes measurement of accommodation and vergence accuracy, amplitude and facility. The accuracy of the accommodative response at

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http://dx.doi.org/10.1016/j.clae.2017.01.003
1367-0484/

near is described by accommodative lag or lead, and for vergence the near phoria. Amplitude of accommodation can be measured monocularly and binocularly through introduction of increasingly minus powered lenses, along with measurement of positive relative accommodation (response to minus lenses) and negative relative accommodation (response to plus lenses). Amplitude of vergence is measured by horizontal fusional convergent and divergent reserve response to induced prism. Facility of both accommodation and vergence is measured by alternating increased and decreased demand to measure swiftness of response [7,12].

An increase in accommodative responses to 0–5 D vergence targets in young adult myopes wearing OK for one month has been previously measured, compared to single vision soft contact lens wear. The authors measured an increase in positive spherical aberration at all vergence targets in OK wear, and their calculations of Zernike defocus indicated reduction of accommodative lags, although the latter were not directly measured [13]. One recent study evaluating accommodative changes in response to OK wear found no significant change in young adults (18–30 years) with low to moderate myopia at baseline and after three months, when compared to adults wearing other unknown corrections. Further comparison of those wearing OK for three months to an age and refraction matched group of OK wearers of at least three years duration demonstrated a significant increase in negative relative accommodation in the long term wearers, but no change in positive relative accommodation, monocular amplitude of accommodation, accommodative lag or monocular accommodative facility [14]. No assessment of vergence function at near in young adult OK wear has been undertaken.

The aim of this study was to undertake a retrospective analysis of clinical records to determine if there are any differences in near binocular vision function between young adults wearing OK compared to those wearing single vision disposable SCLs for myopia correction. Any evident differences in binocular vision function between contact lens wear modalities could affect visual acceptance and frequency of symptoms like asthenopia and headaches [7], as well as in management of binocular vision risk factors in the case of young adult myopia progression [7–10].

2. Methods

2.1. Clinical records

Consecutive clinical records of all OK wearers aged between 18 and 30 years who had presented in an 18 month period (January 2011 to July 2012) at an optometric practice in Brisbane, Australia were reviewed. All participants had given prior informed consent to allow their clinical data to be used for research purposes. The study was approved by the Queensland University of Technology, Human Research Ethics Committee and followed the tenets of the Declaration of Helsinki. The database record search and data recording were conducted by a research assistant who was masked to the purpose of the study.

2.2. OK and SCL groups

All clinical records of OK wearers aged between 18 and 30 years at their most recent presentation were accessed to evaluate available data on age, duration of OK contact lens wear, pre-OK best vision sphere refraction, and binocular vision function. The records were excluded from analysis if there was no available binocular vision data, or if binocular vision treatment had been given at any visit. A negative history for strabismus, amblyopia or ocular pathology, trauma or surgery was also required. The record was also excluded if the binocular vision data was collected when the myopia was not fully corrected (distance sphero-cylindrical refraction result must be within −0.25D to +0.50D inclusive in each eye), or if there was residual astigmatism greater than −0.75DC in any meridian [15]. All binocular vision measurements in the OK group occurred in an unaided state. The records of 17 young adult OK wearers comprised a full set of binocular vision data at their most recent presentation, satisfied all inclusion criteria, and were used in the analysis. Clinical records were searched to find 17 single vision disposable SCL wearers that matched the 17 OK wearers in terms of age, degree of myopia and duration of wear of their contact lens modality, and where the record also had a complete set of binocular vision data collected using the same methods at the most recent presentation. Clinical data was extracted and recorded in a spreadsheet (Microsoft Excel, Washington, USA).

All OK wearers had been fit with Contex E-series lenses (Contex, California, USA) according to the manufacturers fitting guidelines. These lenses are fit using an inventory set where the first lens selected is that matching the flat corneal meridian and target treatment power. If this first lens demonstrates either a tight or loose fit on the eye, the next appropriate lens is selected from the inventory set. A subsequent overnight trial determines if the ideal fit has been achieved and if the selected lens is suitable. Clinical outcomes indicating ideal and non-ideal OK contact lens fits and modification paradigms have been described elsewhere [16].

All except for one of the SCL group wore the same lens type in each eye. Eleven of the SCL group wore spherical CL and six had a toric correction, 13 wore aspheric lenses (Bausch & Lomb Purevision2, Purevision2 Toric, Soflens Toric; Coopervision Biofinity, Biofinity Toric, Proclear; Alcon AirOptix) and 4 non-aspheric lens designs (Johnson & Johnson Oasys Toric, TruEye, Moist, Moist Toric). All of the SCL group were fully corrected as per the OK group, and had only worn a single vision distance modality throughout their clinical history.

2.3. Binocular vision measures

Near point binocular vision data for each record was available in the form of horizontal heterophoria (phoria), horizontal base-in fusional reserves (BIFR) and base-out fusional reserves (BOFR) and accommodation accuracy (AA) at near. Phoria was measured using the estimated cover test at 40cm [17,18]. BIFR and BOFR were determined using the step method with a prism bar in free space, with a 6/9 acuity target at 40 cm. The break point was the prism value at which single vision was no longer maintained, and the recovery point was the prism value at which single vision was regained through fusion. The recovery value was recorded [7,12]. AA (lag or lead) was measured using the monocular estimate method (MEM) retinoscopy at 40cm [19]. These methods have shown good intra- and inter-examiner repeatability in previous studies [17,20–22].

2.4. Statistical analysis

The Statistical Package for the Social Sciences (SPSS, version 21.0, Chicago, USA) was used for statistical analysis. Each data set was evaluated for normality of distribution using Kolgov-Smirnov testing. When normality was not evident, Mann-Whitney *U*-tests of independent groups were applied. Where normality of distribution was confirmed, Student's *t*-Tests were applied. All *t*-Tests were two-tailed, independent type three (unequal variance) tests to compare means in the clinical data between groups and Bonferroni corrections for multiple analyses used to protect against Type I error [23]. Due to the different treatments applied, an independent group analysis was considered appropriate. Chi-Square was used for analysis of potential group differences in

Please cite this article in press as: K. Gifford, et al., Near binocular visual function in young adult orthokeratology versus soft contact lens wearers, Contact Lens & Anterior Eye (2017), http://dx.doi.org/10.1016/j.clae.2017.01.003