

Optical correction and evolution of hipermetropia

Correção óptica e evolução da hipermetropia

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ABSTRACT

Objective: To compare changes in refraction and ocular biometric parameters in hyperopic children with and without full optical correction. **Methods:** Non-randomized prospecting study with 41 subjects (21 males and 20 females) aged 4 to 6 years with accommodative esotropia and or hyperopia between 3 to 6 diopters, select in Hospital Geral Universitário and Oftalmocenter Santa Rosa. The patients were divided in two groups: group 1 for hyperopic patients that did not need to use optical correction or could use partial correction, and group 2 for patients with accommodative esotropia or hyperopia who needed to use full optical correction all the time. The patients were examined to a complete ophthalmological examination, including objective cycloplegic refraction with auto refractometer, optical biometry and corneal topography, in baseline measurements and 3 years after that. Refraction and ocular biometric parameters were compared using T student test. **Results:** The mean initial age was 5.23 ± 0.81 and 5.36 ± 0.74 years; the initial refractive error in average was $+3.99 \pm 0.92$ e $+4.27 \pm 0.85$ D, the initial axial length was 21.42 ± 0.84 and 21.22 ± 0.86 mm, and initial keratometry was 42.55 ± 1.24 e 42.39 ± 1.22 D for group 1 and 2, respectively. In relation to refractive error, there was a significant decrease in group 1 and there was not in group 2 ($p < 0.05$). In relation to axial length, there was significant increase in group1 and there was not in group 2 ($p < 0.05$). The 3-year comparison showed no statistically significant differences in keratometry for both groups. **Conclusion:** This study suggests that full optical correction of hyperopia may inhibit natural emmetropization during early and late childhood.

Keywords: Refraction errors; Hyperopia; Eye/growth & development.

RESUMO

Objetivo: Comparar as alterações da refração e da biometria ocular na população infantil hipermetrópica com e sem correção óptica total. **Métodos:** Realizou-se estudo prospectivo longitudinal não randomizado em 41 pacientes com hipermetropia, entre 3 e 6 dioptrias ou/e com esotropia acomodativa pura nos ambulatórios do Hospital Geral Universitário e Oftalmocenter Santa Rosa, com idade inicial entre 4 e 6 anos. Os pacientes foram divididos em dois grupos, em que o Grupo 1 compôs-se pelos pacientes hipermetrópicas que não necessitavam usar sua correção óptica ou poderiam usá-la parcialmente, e o Grupo 2 por pacientes com esotropia acomodativa pura e pelos hipermetrópicas que necessitavam usar toda sua correção óptica. Os pacientes submeteram-se a exame oftalmológico completo, incluindo refração objetiva em autorrefrator com cicloplegia, biometria óptica e topografia corneana em uma medida inicial e outra 3 anos mais tarde. Comparou-se a refração e parâmetros biométricos com teste T student. **Resultados:** A média da idade inicial foi de $5,23 \pm 0,81$ e $5,36 \pm 0,74$ anos, a refração inicial foi $+3,99 \pm 0,92$ e $+4,27 \pm 0,85$ D, o diâmetro anteroposterior do globo ocular foi de $21,42 \pm 0,84$ e $21,22 \pm 0,86$ mm, e a ceratometria foi de $42,55 \pm 1,24$ e $42,39 \pm 1,22$ D, para os Grupos 1 e 2, respectivamente. Em relação à refração, houve redução significativa do poder esférico no Grupo 1, em 3 anos; e não houve no Grupo 2 ($p < 0,05$). Com relação ao diâmetro anteroposterior do globo ocular, ocorreu aumento significativo no Grupo 1 e não houve no Grupo 2 ($p < 0,05$). Não se verificou diferença significativa na comparação das ceratometrias em 3 anos nos Grupos 1 e 2. **Conclusão:** Estes dados permitiram concluir que a correção total da hipermetropia pode prejudicar a emetropização natural em crianças.

Descritores: Erros de refração; Hipermetropia; Olho/crescimento & desenvolvimento.

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INTRODUCTION

Hypermetropia is the most common ametropia in childhood. Pre-verbal children have a high initial accommodative capacity (12 diopters of accommodation amplitude) that slowly decreases for decades. However, they usually tolerate only low and medium hypermetropias without decreased visual acuity or asthenopia, as long as it is within the limits of their accommodative tolerance.^(1,2) Accommodative tolerance is the ability of the child to be able to exert long-term accommodation without asthenopia or other clinical manifestations. The formula to estimate this value is: $TA = 4.5 - 0.1 \times Y$ (where Y is the age of the child in years).

Because they have such active accommodation, often hypermetropic children who are within their accommodative tolerance wear their glasses irregularly. In turn, children with accommodative esotropia regularly wear their glasses, often due to keeping their binocular parallelism this way.

The emmetropization of the eyeball occurs by changes in the corneal curvature, by growth of the anteroposterior diameter of the eyeball, and by diminution of the dioptric power of the crystalline. The most important changes in the corneal curvature usually occur in the first two years of life.⁽³⁾

Previous studies have not been conclusive on the influence of total hypermetropia correction on its development. However, it is believed that hypermetropic children aged under 10 years and who have used their total optical correction for many years do not naturally regress their hypermetropia. This fact could occur naturally with hyperopic children who do not use their optical correction.

This study was designed to compare hypermetropic child patients with the total optical correction to uncorrected or partially corrected.

METHODS

A non-randomized, longitudinal prospective study was performed at the Ophthalmology ambulatories of Hospital Geral Universitário de Cuiabá and Oftalmocenter Santa Rosa. Patients with initial age between 4 and 6 years were included.

Forty-one patients were selected during the care period of the authors, in a consecutive way, after their decision-makers approved the informed consent term, and met the inclusion and exclusion criteria. The patients were selected for two groups, Group 1 (23 patients) comprising hypermetropic patients who did not use their optical correction or could use partial optical correction (8 patients) within their accommodative tolerance. Group 2 (18 patients) comprised patients with pure accommodative esotropia or who needed continuous use of their hypermetropic optical correction (4 patients).⁽⁴⁾ Only the right eye of every patient was assessed for the study.

Patients with visual acuity of 0.07 or better in both eyes, with hypermetropia between 3 and 6 diopters, with or without pure accommodative esotropia, and with other normal ophthalmologic examinations were included in this study. We excluded candidates with astigmatism greater than 1.00 DC, anisometropia greater than 1.00 R, accommodative esotropia with high CA/A, partially accommodative esotropia, those who did not return for two consecutive reviews or the last one, those who were cycloplegged outside the planned period, those who no longer wear glasses for over 30 days (of patients who should wear glasses continuously), with neurological change, and/or those who did not cooperate nor understood the carrying out of the examinations.

The children were examined by the first author, who measured their visual acuity, refraction in autorefractor (five measurements; the prevalent average power was used) with cycloplegia (cyclopentolate 1% and tropicamide 1% twice, preceded by 1 dro of proximetacaine 0.5%) held 40 min after the last drop of eyedrops, coverage test with and without prisms, ocular motility, biomicroscopy of the anterior segment, funduscopy, computed tomography and optical biometry as to measure the anteroposterior diameter of the eyeball (DAP). A second complete evaluation was held 3 years later. Other half-yearly evaluations in this interval did not have cycloplegia, computerized keratometry or biometry.

The statistical analysis was done using the software SPSS for Windows (Statistical Package for Social Sciences, version 9.0, SPSS Inc., Chicago, USA). Continuous variables were compared using the Student t test, and the categorical variables using the Chi-square test. The longitudinal changes for each parameter (refraction, keratometry and DAP) were analyzed with the Student's t-test. $P < 0.05$ was considered statistically significant.

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RESULTS

Of the 41 patients, 21 (51.21%) were male and 20 (48.79%) female. The average age was 5.23 ± 0.81 and 5.36 ± 0.74 years, and the average initial hypermetropia was 3.99 ± 0.92 and 4.27 ± 0.85 D, the average initial was 21.42 ± 0.84 e 21.22 ± 0.86 mm, the average keratometry was 42.55 ± 1.24 and 42.39 ± 1.22 D for groups 1 and 2, respectively.

Of the 23 patients from Group 1, one was excluded for not having returned to the final evaluation, and of the 18 from Group 2, four were excluded, one for not wearing glasses continuously, two for not returning for the final evaluation, and one for having refraction with cycloplegia outside the period determined in this study.

Regarding the data collected at the study onset and 3 years later, there was significant reduction of hypermetropia in Group 1 (from 3.99 to 3.00 D, $p < 0.05$), and there was no significant reduction of hypermetropia in Group 2 (from 4.27 to 4.16 D, $p < 0.05$). Regarding DAP, there was an increase in Group 1 (from 21.42 to 21.89 mm, $p < 0.05$), and there was no significant increase in Group 2 (from 21.22 to 21.34 mm, $p < 0.05$). There was no difference in the K of the two groups. Compared to the average ages, there were no significant differences in the refractions and DAP between male and female.

Figure 1 shows the negative influence of the total optical correction of hypermetropia on emmetropization.

Figure 2 shows the negative influence of the total optical correction of hypermetropia on the increase of DAP.

DISCUSSION

The growth of the eyeball is bigger in myopic, lower in emmetropic, and even lower in hypermetropic patients. The compensation of this increase in this population is made by the crystalline. Therefore, for the emmetropization to occur in hypermetropic patients of this age group studied, it would be necessary to have a higher growth of the eyeball and/or a lower rectification of the curves of the lens.⁽⁵⁾

For decades it has been discussed how much to prescribe hypermetropia to orthophoric children with asthenopia, since it has been considered only how much of the correction of hypermetropia would be satisfactory to ameliorate the symptoms, and

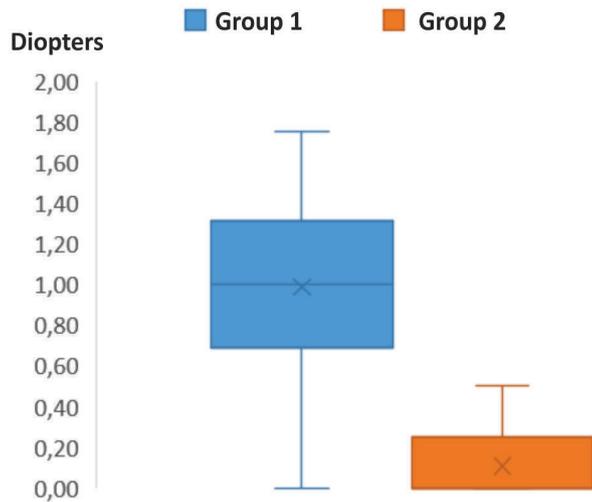


Figure 1. Difference between refraction measurements in 3 years (in Diopters)

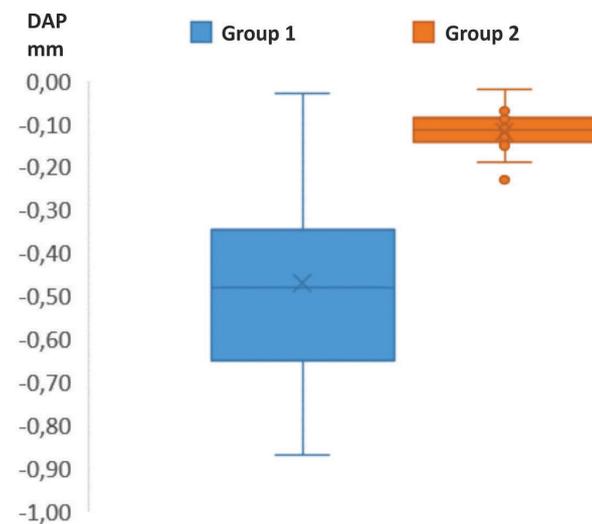


Figure 2. Difference between measurements of the anteroposterior diameter of the eyeball in 3 years (in mm).

it had not been considered if the total correction may or may not influence the ocular emmetropization. There are very few studies in the literature on this topic, and some point out controversial results. Two of them have demonstrated the interference of total correction in emmetropization of the child, and this study corroborated these findings.^(6,7) We believe that children can reduce from 0.25 to 0.37 D/year, from 4 to 15 years. Another study showed that there is no difference in younger children. However, this last study carried out exams under cycloplegia quarterly, which seems to interfere with the process of modeling the crystalline, one of the pillars of emmetropization in the child-juvenile population.^(5,8)

Not all hypocorrected or uncorrected patients show important reduction of hypermetropia. In this study, it was found that patients who had eyes smaller than 20.0 mm did not reduce their hypermetropia. These eyes may have thicker sclerae, which

would prevent the natural growth of the eyes so that emmetropization occurs.

Some authors consider that the non-correction of hyperopia manifested in children could be a risk factor for the development of accommodative esotropia. However, an extensive review of Cochrane in 2014 found no significant association.⁽⁹⁾

Another factor that could interfere with emmetropization is amblyopia. Studies indicate that it may interfere with this process, but other authors have not found this fact.⁽¹⁰⁾

Recently, it has been proposed that the non-correction of hypermetropia manifested above the accommodative tolerance may interfere with school learning.⁽¹¹⁾

Some studies have observed an increase in hyperopia in the first years of life. This may be related to the non-use of cyclopentolate for cycloplegia in children younger than 2 years, or even greater changes in the corneal curvature that occurs in the first years of life.⁽³⁾

This study presents some limitations, one of which is that it did not objectively evaluate the accommodation amplitude, near point, and curvature of the crystalline, due to the difficulties of measuring methods in children of about 4 years, and the lack of an apparatus that accurately measures the curvature of the crystalline. Secondly, it would be preferable to compare the group with accommodative esotropia treated with total correction of hypermetropia to a group with the same pathology, but not using their total correction. However, this did not seem ethical. An alternative would be not to include the group with accommodative esotropia, and consider only orthophoric patients. This would leave a very small number of participants with a high bias of children who would have to wear their glasses continuously, which this group does not do so often. Finally, the number of participants and follow-up would be preferable to better clarify the emmetropization in the child-juvenile population.

CONCLUSION

The results showed that the constant use of total optical correction of hypermetropia inhibits the natural process of emmetropization in greater hypermetropia during childhood. Non or partial optical correction, when necessary, helped in the process of the child's emmetropization, with the exception of infants with minor PAD. Other larger studies are required for data from other regions in Brazil to be analyzed, and the reference value for DAP to be more accurate, which could interfere with emmetropization, is referred.

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