Original article

Effect of unilateral congenital cataract surgery on ocular axial length growth and corneal flattening

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ABSTRACT

Objective: The aim of this article is to study the effect of unilateral congenital cataract surgery on ocular growth and corneal flattening.

Methods: This is a cross-sectional study of 59 patients operated on due to a unilateral congenital cataract. The median age of the patients at the time of diagnosis was 17 months (interquartile range, 5–39 months). The median age at cataract the time of surgery was 28 months (interquartile range, 8–52 months), and the mean follow-up between cataract surgery and assessments was 149.7 ± 69.9 months (range, 30–319 months). Axial length and corneal curvature were measured in both operated and non-operated eyes, comparing the results between them.

Results: There were no statistically significant differences for axial length growth or corneal flattening between operated and non-operated eyes: axial length (P = .327, Student t test) and corneal curvature (P = .078, Student t test). A sub-analysis was performed using the visual acuity and the age of the patient at the time of surgery. The only statistically significant data (P = .007, Student t test) was a lower axial length in operated eyes compared to non-operated eyes, in the non-deep-amblyopia group.

Conclusions: No significant axial length growth modifications were observed between operated and non-operated eyes. Only the non-deep-amblyopia group presented with a lower axial length in the operated eyes compared to non-operated eyes. No significant differences in corneal flattening were found between groups after unilateral congenital cataract surgery.

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Efecto de la cirugía de las cataratas congénitas unilaterales sobre el crecimiento ocular axial y el aplanamiento corneal

RESUMEN

Objetivo: Estudiar el efecto de la cirugía de las cataratas congénitas unilaterales sobre el crecimiento ocular y el aplanamiento corneal.

Métodos: Realizamos un estudio transversal sobre 59 pacientes intervenidos de cataratas congénitas unilaterales. La mediana de edad de los pacientes en el momento del diagnóstico fue de 17 meses (rango intercuartílico: 5-39 meses), la mediana de edad en el momento de la intervención fue de 28 meses (rango intercuartílico: 8-52 meses) y el tiempo medio de seguimiento fue de 149,7 ± 69,9 meses (rango: 30-319 meses). Se midió la longitud axial y la curvatura corneal de ambos ojos en todos los pacientes, tanto los operados de catarata congénita como los no operados. Estos valores fueron comparados entre sí.

Resultados: No se evidencian diferencias estadísticamente significativas entre ambos ojos (operados y no operados) respecto a la longitud axial (p = 0,327, prueba t de Student) ni a la curvatura corneal (p = 0,078, prueba t de Student). Al realizar un subanálisis dependiendo de la agudeza visual y la edad de los pacientes en el momento de la intervención, encontramos diferencias estadísticamente significativas solo respecto a la longitud axial en el grupo de pacientes que no presentan ambliopía profunda (p = 0,007, prueba t de Student), con menor longitud axial en los ojos intervenidos respecto a los ojos sanos.

Conclusiones: No encontramos cambios significativos en el crecimiento axial de los ojos intervenidos de catarata congénita unilateral respecto a sus ojos adelfos. Solo encontramos menor longitud axial en los ojos intervenidos con respecto a los ojos sanos en el grupo que no presentaba ambliopía profunda. No se hallaron diferencias respecto al aplanamiento corneal en los ojos operados con respecto a los ojos adelfos tras la cirugía de las cataratas congénitas unilaterales.

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Introduction

Increased axial length (AL) of the eye, together with flattened corner curvature, are the most significant factors for refractive changes that occur in the human eye during growth. The most important axial length increase of the ocular globe takes place in the first 18 months of life\(^1\) while the keratometric change takes place mainly during the first 3–6 months.\(^1,2\) For these reasons, in congenital cataract pediatric surgery it is recommended to diminish the diopter power of the intraocular lens (IOL) which initially causes hypermetropia which gradually will tend to emmetropia or moderate myopia in adulthood. Accordingly, Dahave et al.\(^3\) recommend correcting the calculated emmetropic power 20% in children under 2 years of age due to the rapid changes in axial length and keratometry readings in this period of life. While in children between 2 and 8 years they recommend 10% hypo-correction as said changes take place at a slower rate.

The objective of this study is to assess the effect on ocular growth and corneal flattening of unilateral congenital cataract surgery by means of studying AL and corneal curvature in children who were intervened for congenital cataract in one eye, and comparing said parameters with the contralateral healthy eye.

Materials and methods

A transversal study on a group of 59 patients who accepted and signed an informed consent to participate in the study, out of 120 unilateral congenital cataract operations carried out consecutively between January 1982 to September 2004 at the Pediatric Ophthalmology Department in the University Hospital La Fe of Valencia.

All the surgeries were carried out by 3 surgeons in said period of time applying similar surgical procedures. Under general anesthesia, a corneal incision between 3.5 and 6.5 mm was made depending on the IOL to be implanted and, after performing anterior capsulotomy with diathermy, the lens material was removed by aspiration with a Simcoe cannula. In 48 eyes the following IOL were implanted: 41 IOL in capsular sac, 1 OIL in anterior chamber and 6 IOL sutured to sulcus. Eleven eyes were left aphakic, with contact lens adaptation for these patients. Only in 31 cases the implanted IOL type was identified: 15 IOL “Pharmacia 808C”, 6 “AMO PC56LB”, 5 “Pharmacia 722C”, 3 “Pharmacia 722Y”, one “Pharmacia 720A”, and one “Allergan PC40NB” IOL. In 14 eyes, the posterior capsule was left intact and in 22 eyes continuous circular posterior capsulotomy (CCPC) was performed with diathermy or mechanically, and in 23 eyes CCPC was associated to anterior vitrectomy. Residual viscoelastic was removed with a Simcoe...
Table 1 - Axial length and keratometry values of operated eyes and healthy eyes.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OE mean ± TD</th>
<th>HE mean ± TD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial length (mm)</td>
<td>22.81 ± 2.74</td>
<td>23.09 ± 0.95</td>
<td>0.327 (NSSD)</td>
</tr>
<tr>
<td>Keratometry (D)</td>
<td>44.26 ± 2.73</td>
<td>43.76 ± 1.63</td>
<td>0.078 (NSSD)</td>
</tr>
</tbody>
</table>

D: diop ters; TD: typical deviation; mm: millimeters; NSSD: non-statistically significant difference; OE: operated eyes; HE: healthy eyes.

The sample (59 eyes) corresponds to 32 males and 27 females. The median age at diagnosis was 17 months (IQR: 5–39 months), with the median age at surgery being 28 months (IQR: 8–52 months). The mean follow-up time after surgery up to the evaluation visit was 149.7 ± 69.9 months (range: 30–319 months).

The AL statistical values for operated and healthy eyes are shown in Table 1. Similar median values between both groups can be observed. The qualitative results are shown in Fig. 1.

The T for student test for comparison mean values is applied again, obtaining a P value of 0.078 (>0.05) and accordingly the mean keratometry of operated eyes is not significantly different to that of healthy eyes.

A sub-analysis was performed, dividing the sample on the basis of visual acuity (VA) in 2 Groups: patients with deep amblyopia (VA < 0.1), and patients without deep amblyopia (VA ≥ 0.1). VA was assessed with the Snellen or Pigassou test. The statistical values for AL and keratometry are shown in Tables 2 and 3 respectively. Here the T for student test was also applied for comparing mean values, in which statistically significant differences were found only in the IL of the group without deep amblyopia, (P = 0.007) with lower AL in operated eyes vis-à-vis healthy eyes.

An additional subanalysis was carried out dividing the sample per age at surgery in 3 groups: patients with age at surgery <12 months, between 12 and 30 months and >30 months. Results for AL and keratometry are shown in Tables 4 and 5 respectively. No statistically significant differences were found in AL or keratometry between intervened eyes.
and healthy eyes in any of the 3 groups (T for student test for comparing mean values).

**Discussion**

Several studies have been carried out on animals to assess the effect of cataract surgery on AL. Lambert et al.\(^4\) concluded that extracting the lens and implanting IOL in monkeys delays ocular growth, although this is dependent on age, with very small effect in monkeys of 7.5 months or older.\(^5\) Other studies\(^6,7\) obtained similar results, concluding that the AL of aphakic eyes in monkeys is shorter in comparison with non-operated eyes.

In addition, several studies report contradictory results about the effect of pediatric cataract surgery on ocular growth. It is difficult to make comparisons between said studies due to the different inclusion and exclusion criteria, different designs (retrospective, prospective and transversal studies), type of cataract (congenital, progressive and traumatic), laterality (bilateral, unilateral), age at surgery and aphakia correction method.

The advantages of the present study include the larger number of the sample in comparison with published articles and the sub-analysis to determine the presence or absence of deep amblyopia and based on age at surgery. The disadvantage is the absence of AL or keratometry data prior to surgery in a large percentage of eyes.

With similar results to the present study, the majority of studies agree in the absence of difference in ocular growth between intervened and non-intervened eyes.\(^8-13\) Accordingly, in a prospective study on 36 eyes intervened for congenital cataract, Hussin et al.\(^8\) did not find statistically significant differences vis-à-vis baseline AL or during the development of the study between intervened and control eyes, despite the fact that the growth in the intervened eyes (4.83 ± 1.44 mm) was larger than the growth of the control eyes (4.49 ± 1.32 mm). In a retrospective study on 45 children intervened for unilateral congenital cataract’s, Sminia et al.\(^9\) did not find statistically significant ocular growth differences between operated and healthy eyes. In turn, a study by Inatomi et al.\(^10\) on 15 children intervened for unilateral congenital cataracts with a mean age at surgery of 9.7 years (5–15 years) found no statistically significant differences in AL between intervened and non-intervened eyes. An additional study by Flitcroft et al.\(^11\) on 35 eyes of 24 children diagnosed with congenital and progressive cataracts concluded that the ocular growth pattern is similar in both groups (intervened and healthy eyes). No significant acceleration or delay was found in AL growth in pseudophakic eyes compared to normal eyes. A study by Zoor et al.\(^12\) on 47 pediatric cataracts (31 cases of bilateral congenital cataracts and 16 post traumatic unilateral cataracts) concluded that cataract surgery with or without IOL implant does not delay axial growth in children older than one year. In a study on 16 children diagnosed with congenital and traumatic cataracts (14 unilateral

<p>| Table 2 – Comparison of axial length results in deep amblyopia group vs non-deep amblyopia group. |</p>
<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of cases</th>
<th>OE (Mean ± TD) in mm</th>
<th>HE (Mean ± TD) in mm</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep amblyopia</td>
<td>39</td>
<td>23.23 ± 3.05</td>
<td>23.15 ± 1</td>
<td>0.859 (NSSD)</td>
</tr>
<tr>
<td>Non-deep amblyopia</td>
<td>19</td>
<td>21.94 ± 1.72</td>
<td>23.01 ± 0.86</td>
<td>0.007 (SSD)</td>
</tr>
</tbody>
</table>

SSD: statistically significant difference; TD: typical deviation; mm: millimeters; NSSD: non-statistically significant difference; OE: operated eyes; HE: healthy eyes.

* T for student test for related samples.

<p>| Table 3 – Comparison of results of keratometry on the basis of deep-amblyopia group vs non-deep-amblyopia group. |</p>
<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of cases</th>
<th>OE (Mean ± TD) in D</th>
<th>HE (Mean ± TD) in D</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep amblyopia</td>
<td>39</td>
<td>44.25 ± 2.99</td>
<td>43.52 ± 1.37</td>
<td>0.082 (NSSD)</td>
</tr>
<tr>
<td>Non-deep amblyopia</td>
<td>19</td>
<td>44.27 ± 2.18</td>
<td>44.23 ± 2.07</td>
<td>0.784 (NSSD)</td>
</tr>
</tbody>
</table>

TD: typical deviation; D: diopters; NSSD: non-statistically significant difference; OE: operated eyes; HE: healthy eyes.

* T for student test for related samples.

<p>| Table 4 – Comparison of axial length results for age at surgery group. |</p>
<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of cases</th>
<th>OE (Mean ± TD) in mm</th>
<th>HE (Mean ± TD) in mm</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 months</td>
<td>20</td>
<td>23.02 ± 3.19</td>
<td>23.12 ± 1.13</td>
<td>0.860 (NSSD)</td>
</tr>
<tr>
<td>12–30 months</td>
<td>9</td>
<td>21.75 ± 3.15</td>
<td>22.66 ± 1.05</td>
<td>0.327 (NSSD)</td>
</tr>
<tr>
<td>&gt;30 months</td>
<td>29</td>
<td>22.98 ± 2.26</td>
<td>23.23 ± 0.76</td>
<td>0.512 (NSSD)</td>
</tr>
</tbody>
</table>

TD: typical deviation; mm: millimeters; NSSD: non-statistically significant difference; OE: operated eyes; HE: healthy eyes.

* T for student test for related samples.
and 2 bilateral), Kora et al. did not find a significant difference in AL growth post-surgery between intervened and healthy eyes.

Very few studies give room for doubt about the above conclusions. After assessing 11 children intervened for unilateral congenital cataracts with a follow-up period of 5.6 years, Griener et al. suggested that some pseudophakic children may exhibit AL reduction in comparison with normal eyes. This conclusion was based on the fact that most of his patients (7/11) presented smaller mean axial growth in operated eyes in comparison with nonoperated eyes. This result is similar to the subgroup without deep ambioplya of the present study in which lower AL was observed in the group of operated eyes in comparison with the group of healthy eyes (Table 2). An opposite conclusion was reported by Leiba et al. who, after carrying out a retrospective study on 20 children intervened for unilateral, bilateral and traumatic congenital cataracts, found a tendency toward greater ocular growth in pseudophakic eyes vis-à-vis normal eyes. A similar result was reported by Vasavada et al. who, in their observational prospective study on 158 eyes of 79 children, found that in the unilateral congenital cataract group, intervened eyes of children aged 12 months or less exhibited greater axial growth in comparison with healthy eyes. In the present study, no statistically significant differences were found for AL between intervened and healthy eyes in any of the 3 subgroups per age at surgery (Table 4).

In what concerns corneal curvature, Capozzi et al. concluded that corneal curvature in eyes with unilateral congenital cataract is greater than in healthy eyes. Whereas, similarly to the present study, other studies did not find statistically significant differences in corneal refractive power between operated and nonoperated eyes, with the advantage that in the present study this result was obtained in both subanalyses in the presence or absence of deep ambioplya and according to age at surgery.

In conclusion, the present study has observed that the mean AL in unilateral congenital cataract eyes which underwent surgery does not significantly differ from eyes which did not undergo surgery, with the exception of the non-deep ambioplya group where lower AL was observed in operated eyes vis-à-vis healthy contralateral eyes. In addition, no statistically significant differences were found in keratometry between intervened and healthy eyes.

Table 5 – Comparison of keratometry results for age-at-surgery group.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of cases</th>
<th>OE (Mean ± TD) in D</th>
<th>HE (Mean ± TD) in D</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 months</td>
<td>20</td>
<td>44.69 ± 3.84</td>
<td>43.60 ± 1.32</td>
<td>0.167 (NSSD)</td>
</tr>
<tr>
<td>12–30 months</td>
<td>9</td>
<td>43.66 ± 1.76</td>
<td>43.40 ± 1.40</td>
<td>0.342 (NSSD)</td>
</tr>
<tr>
<td>&gt;30 months</td>
<td>29</td>
<td>44.14 ± 2</td>
<td>43.96 ± 1.92</td>
<td>0.351 (NSSD)</td>
</tr>
</tbody>
</table>

D: diopters; TD: typical deviation; NSSD: non-statistically significant difference; OE: operated eyes; HE: healthy eyes.

* T for student test for related samples.

Conflict of interest

No conflict of interests has been declared by the authors.

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