Original Article

Biometric changes in Indian pediatric cataract and postoperative refractive status

Sudarshan Kumar Khokhar, Ankit Tomar, Ganesh Pillay[1], Esha Agarwal

Purpose: To prospectively evaluate the biometric changes in Indian pediatric cataract and postoperative refractive status. **Methods:** A total of 147 patients were recruited into three groups: age <6 months, age between 7 months and 18 months, and age between 19 and 60 months and prospectively observed for 6 months. Exclusion criteria were preterm birth, microphthalmia, microcornea, megalocornea, uveitis, glaucoma, and traumatic or complicated cataract. Axial length and keratometry, the primary outcome measures, were taken preoperatively under general anesthesia before surgery. These children were followed up for 6 months to look for refractive and biometric changes. T-test and linear regression with the logarithm of independent variables were done. **Results:** All unilateral cataractous eyes (n = 25) and randomly selected bilateral cases (n = 122) were included in the analysis, for a total of 147 eyes. Mean age was 17.163 ± 13.024 months; axial length growth was 0.21, 0.18, 0.06 mm/month, and keratometry decline was 0.083, 0.035, 0.001 D/month in age groups 0–6, 7–18, and 19–60 months, respectively. The visual acuity improved in log MAR from 1.020 to 0.745 at 6 months postoperatively. There was statistically significant (Spearman's correlation coefficient = –0.575, P < 0.001) between age and postoperative refraction. There were no intraocular lens (IOL)-related complications seen in the immediate postoperative period. Peripheral opacification was seen in 102 eyes and central opacification in 1 eye at a 6-month follow-up. **Conclusion:** Indian eyes have a lower rate of axial length growth and keratometry change in comparison with western eyes implying smaller undercorrection in emmetropic IOL power for Indian pediatric eyes to achieve a moderate amount of hyperopia.

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Childhood blindness has been a priority under the World Health Organization (WHO) global initiative for the elimination of avoidable blindness by the year 2020.[1] Studies done in South India and Chile showed that lens abnormalities contributed to 7.4% and 9.2% of blindness, respectively.[2]

The critical period of vision development, binocular interaction, and stereopsis range from 2 to 6 months of age.[3] The management of pediatric cataract and the intraocular lens (IOL) placement is well defined above the age of 2 years, but there is controversy regarding placement of the IOL in the age group of 2 months to 2 years.[4] The axial length growth and keratometry change have been different in studies.[5,6] The IOL power calculation in pediatric cataract is still a matter of debate and is dependent on preoperative biometry as well as on predicting the postoperative change.[7] The primary objective of our study was to evaluate the biometric changes in Indian pediatric cataractous eyes which included axial length, keratometry preoperatively as well as postoperatively and postoperative refractive status in pseudophakic eyes. Also, we assessed the association of the morphology of cataract with changes in biometry and recorded the incidence of adverse events following cataract surgery.

Methods

A total of 147 patients pediatric cataract were recruited from the outpatient department of a tertiary eye center. The cases were recruited in three groups according to the pattern of biometric changes in age < 6 months, age between 7 and 18 months and age between 19 and 60 months. The study was prospective and observational in nature under general anesthesia and the study protocol adhered to the tenets of the Declaration of Helsinki. The study was started after ethical clearance from the institutional review board and written informed consent being obtained from the guardian of each patient. The cataractous eye of unilateral and bilateral congenital cataracts served as a case. Visually significant congenital cataract (3 mm central opacity or 2.5 mm central opacity with associated abnormal movements or deviation of the eye) in one or both eyes and children with age at least 41 postconceptional weeks at the time of cataract surgery were

Unit of Lens, Refractive and Pediatric Cataract, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, Ansari Nagar, New Delhi, [1]Unit of Pediatric Ophthalmology, ASG Eye Hospital, Arera Colony, Bhopal, Madhya Pradesh, India

Correspondence to: Dr. Ganesh Pillay, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi - 110 029, India. E-mail: ganesh.pillay@gmail.com

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included in the study. Post-traumatic or complicated cataract, children with previous intraocular surgery and glaucoma were excluded from the study.

Preoperative assessment

All patients underwent a complete ophthalmic examination including distant direct and slit-lamp examination to evaluate the morphology of cataract, visual acuity by Teller Acuity Chart and Cardiff Acuity chart wherever possible or else visual evoked response was done. The child was also evaluated for the presence of nystagmus and squint. In cases where fundus examination was not possible by indirect ophthalmoscopy, ultrasonography was done for posterior segment evaluation.

Perioperative workup (under anesthesia) included Axial length using Contact A-scan Biometry (Sonomed, Lake Success, NY, USA) with maximum anterior chamber depth reading. Keratometry was done using a handheld keratometry (Nidek KM-500). The site of IOL implantation and complications if any were separately noted. Clinical Photographs of patients were taken from the intraoperative video recording. Postoperatively, the patients were administered topical moxifloxacin 0.5% (Vigamox, Alcon Laboratories, Fort Worth, Tx) four times a day, topical prednisolone phosphate 1% (P-lone, Syntho Pharmaceuticals, Lucknow, India) six times a day which was tapered on subsequent follow-ups and a short-acting cycloplegic tropicamide 1% (Auromide, Aurolabs, India) thrice a day. Postoperative refraction on day 1 postsurgery as well as on follow-up at 1, 3, and 6 months evaluation under anesthesia was done and axial length using contact A scan biometry, keratometry, refraction using retinoscopy and autorefractometer, corneal diameters, intraocular pressure, fundus examination, visual axis opacification, and any postoperative complication were recorded.

Surgical method

All surgeries were done by the same surgeon (SK). The surgery included lens aspiration with manual posterior continuous curvilinear capsulorhexis (CCC) and anterior vitrectomy along with IOL implantation was done. A single-piece IOL in the bag was implanted or three-piece lens in sulcus was implanted in case both CCC are not contiguous. The formula for calculating IOL power used was SRK II. No IOL was implanted for eyes <17 mm axial length and white–white <9 mm.

Statistical analysis

The *t*-test was used for the analysis of the data collected. Tests of significance were performed using the SPSS software (SPSS Inc., Chicago, IL, USA).

Results

A total number of 350 patients were screened out of which 171 were eligible.

After obtaining written informed consent from the parents, 168 patients were enrolled, and 147 patients completed a 6-month follow-up. All unilateral cataractous eyes (n = 25) and randomly selected bilateral eyes (n = 122) were included in the analysis, for a total of 147 eyes. Mean age of the study subjects was: 17.169 ± 13.024 months out of which 60.5% were male and 39.5% were female. IOL was implanted in 147 eyes. Out of unilateral cataracts, the right eye was involved in 8 eyes and left eye was involved in 17 eyes.

The study subjects were divided into three groups according to the pattern of growth seen in pediatric eyes: 0–6, 6–18, and 18–60 months [Fig. 1]. The most common morphology in the age group 0–6 months was total cataract and in the age groups 6–18 months and 18–60 months was the zonular cataract [Table 1]. Intraoperatively, the posterior capsular plaque was found in 21 eyes (14.28%), anterior capsular plaque in 13 eyes (8.8%), and pre-existing posterior capsular defect in 12 eyes (8.1%) (6 eyes with unilateral cataract and 6 eyes with bilateral cataracts). Among unilateral cataractous eyes, strabismus was present in 22 patients (62.85%), 14 (63.63%) eyes had esotropia and 8 (36.36%) eyes had exotropia and among bilateral cataractous eyes, strabismus was present in 18 patients (14.75%), 9 patients (50%) had esotropia, 4 patients (22.2%) had exotropia, and 1 patient (5.5%) had alternate convergent squint and 4 patients (22.2%) had alternate divergent squint.

Nystagmus was seen in 17 patients, with 8 patients (16 eyes) having jerky nystagmus and 9 patients (18 eyes) having nystagmoid movements. Average white to white diameter was 10.870 ± 0.561 mm. Preoperatively, the most common astigmatism encountered was with the rule and 6 months postoperatively, it was oblique. The IOL was placed in the bag in 125 eyes (hydrophobic aspheric single piece (AMO Tecnis) and in sulcus in 22 eyes (hydrophobic aspheric multipiece (AcrySof multipiece). The IOL power was calculated using SRK II formula and the average emmetropic and reduced IOL powers and the percentage undercorrection for different age groups are shown in Table 2. The average intraocular pressure in different age groups ranges from 10.2 to 10.9 ± 2.218 mm Hg. There was no central posterior capsular opacification seen in the first month but 42 eyes developed peripheral opacification at 3 months. Only 1 eye had central opacification and 102 eyes had peripheral opacification at 6 months of follow-up.

Table 1: Different cataract morphology in the different age groups

	0-6 months (N=30)	6-18 months (N=62)	18-60 months (N=55)
Zonular cataract	5 (17%)	24 (39%)	25 (45%)
Total cataract	16 (53%)	19 (31%)	23 (42%)
Nuclear cataract	6 (20%)	5 (8%)	3 (5%)
Membranous cataract	1 (3%)	6 (10%)	1 (2%)
Posterior lenticonus	0	2 (3%)	1 (2%)
Persistant fetal vasculature	2 (7%)	4 (6%)	2 (4%)
Morgagnian cataract	0	1 (1.5%)	0
Posterior subcapsular cataract	0	1 (1.5%)	0

A one-way between-subject's ANOVA was conducted to compare the axial lengths, keratometry, and refraction at different time points in all subjects and at different time points in different age groups. There was a significant difference at the P <.05 level for the mean axial length, keratometry, and refraction at baseline, first month, third month, and sixth months follow-up [Fig. 2a and b]. *Post hoc* comparisons indicated a significant difference between all the pairs. The mean axial length at baseline for all study subjects was 20.746 ± 1.803 mm which increased to a mean of 21.681 ± 1.429 mm over the 6-month period of follow-up. The mean axial length was smaller for the younger age group. The median axial growth rates observed in 0–6, 6–18, and 18–60 month age groups were 0.21, 0.18, and 0.06 mm/month, respectively [Fig. 2b]. The mean keratometry for all subjects was 44.474 ± 2.455 D which reduced to 44.103 ± 2.310 D with a median decline in keratometry in 0–6, 6–18, and 18–60 month age groups were –0.083, –0.035, and 0 D/month, respectively [Fig. 2c and d]. Kruskal–Wallis H test showed that there was a statistically significant difference in the rate of change in axial length between the different age groups, χ^2 (2) = 58.129, P < 0.001, in the rate of change in keratometry between the different age groups, χ^2 (2) = 13.175, P = 0.001, and in the rate of change in mean refractive spherical

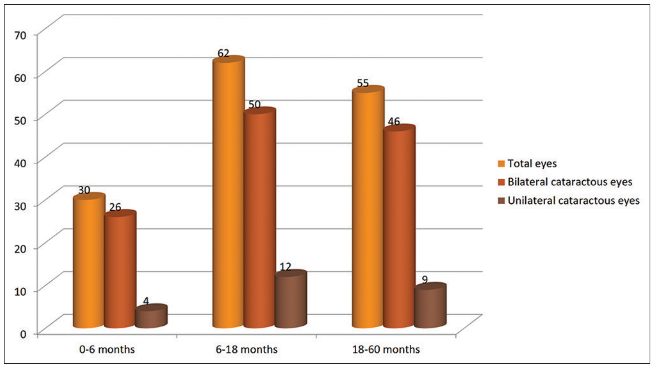

Figure 1: Total number of eyes in different age groups

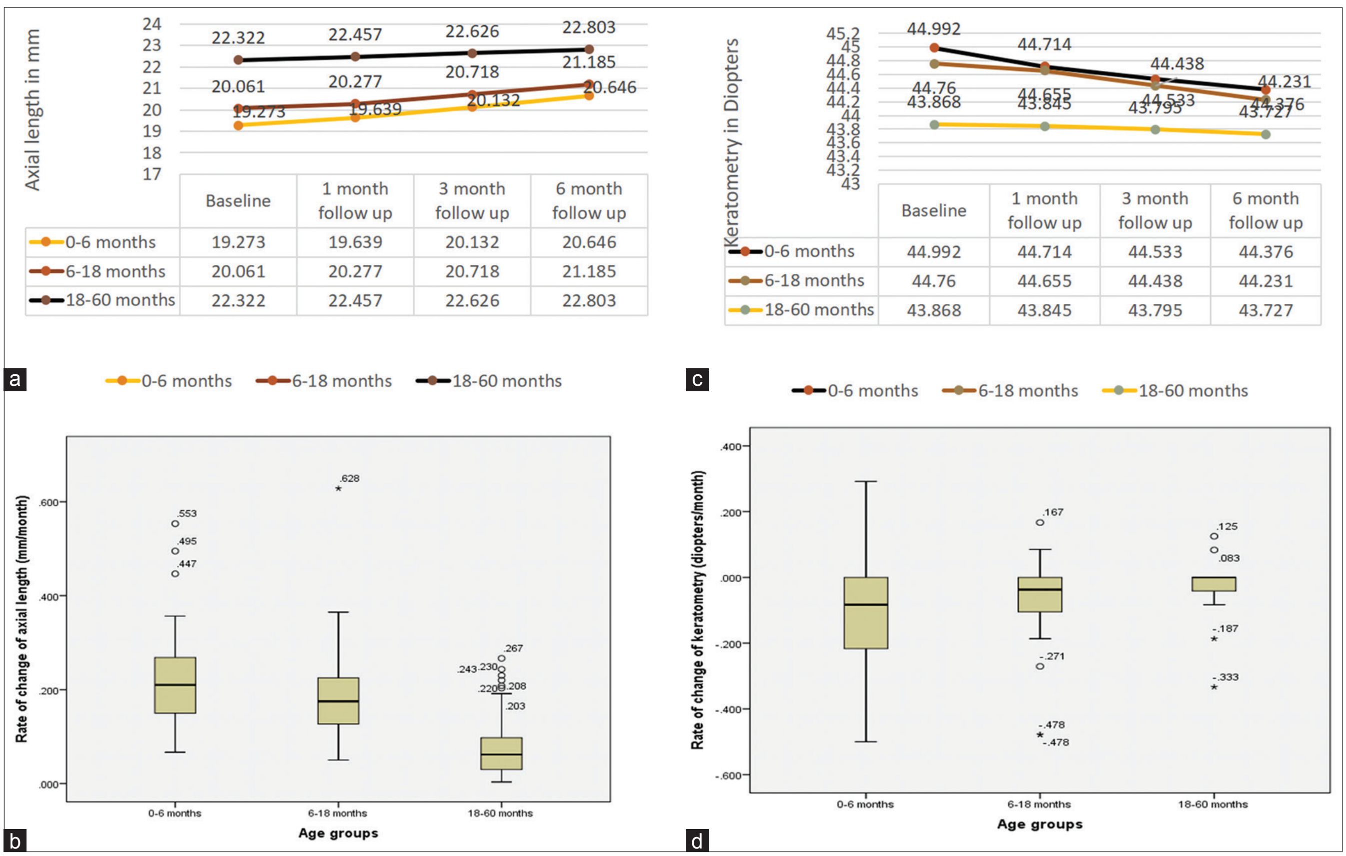

Figure 2: (a) Comparison of axial length changes with time between different age groups. (b) Box plot graph showing the rate of change of axial length in different age groups. (c) Comparison of keratometry changes with time in different age groups. (d) Rate of change of keratometry in different age groups

Table 2: Average emmetropic IOL power, reduced IOL power, and percentage undercorrection in different age groups

	0-6 months	6-18 months	18-60 months
Emmetropic IOL power (diopters)	30.057±2.790	28.155±4.092	23.394±3.971
Reduced IOL power (diopters)	25.480±2.585	25.137±3.695	22.372±3.426
Percentage undercorrection	15.169±3.963	10.590±4.909	3.683±3.651

IOL: intraocular lens

equivalent between the different age groups, χ^2 (2) = 42.517, $P < 0.001$.

Kruskal–Wallis H test showed that there was no statistical significance in the rate of change in axial length, keratometry, or mean refractive spherical equivalent between the different morphology groups.

There was a strong, negative correlation between age and percentage reduction in emmetropic IOL power, which was statistically significant (Spearman's correlation coefficient = –0.836, $P < 0.001$, R^2 linear = 0.573). There was a strong, negative correlation between baseline axial length and percentage reduction in emmetropic IOL power, which was statistically significant (Spearman's correlation coefficient = –0.687, $P < 0.001$, R^2 linear = 0.404). There was a strong, negative correlation between age and day 1 postoperative refraction (mean refractive spherical equivalent), which was statistically significant (Spearman's correlation coefficient = –0.764, $P < 0.001$, R^2 linear = 0.511) [Fig. 3a]. There was a strong, positive correlation between day 1 postoperative refraction (mean refractive spherical equivalent) and percentage reduction in emmetropic power, which was statistically significant (Spearman's correlation coefficient = 0.726, $P < 0.001$, R^2 linear = 0.494). There was a strong, negative correlation between the rate of change in axial length and the rate of change in mean refractive spherical equivalent, which was statistically significant (Spearman's correlation coefficient = –0.546, $P < 0.001$, R^2 linear = 0.437) [Fig. 3b].

The mean visual acuity was measurable in 24 eyes at baseline and was log MAR 1.020 ± 0.405, and at 6 months postoperatively, the mean visual acuity was measurable in 106 eyes and was log MAR 0.745 ± 0.336. The Wilcoxon signed-rank test was used to assess the improvement in visual acuity in logMAR. It showed that there was a statistically significant change in visual acuity from baseline to each subsequent follow-up.

Discussion

There were total of 147 pediatric patients who completed a 6-month follow-up in our study who had unilateral or bilateral cataract and underwent cataract surgery. The most common morphology encountered in our study was total cataract (39%) followed by zonular cataract (37%), compared with the infant aphakia treatment study[8] where nuclear cataract was most common (54%).

Squint was present in 40 patients (27.21%) comparable with the infant aphakia treatment study. In concordance with the previous literature, there was a significant correlation between age and baseline axial length. Wilson *et al*.[6] studied the biometric changes in Caucasian pediatric eyes following cataract surgery and the study subjects had a mean axial length of 20.52 ± 2.87 mm and a growth rate in 0–6, 6–18, and 18–60 months was 0.62, 0.19, and 0.01 mm/month, respectively. The rate of biometric changes in Caucasian eyes, as seen by Capozzi *et al*.,[5] was 0.46 mm/month in the first 6 months, 0.15 mm/month in the second semester, and 0.10 mm/month in the second year. In our study, we found it to be 0.21 mm/month in the first 6 months, 0.18 mm/month between 7 and 18 months, and 0.06 mm/month between 19 and 60 months. The Indian pediatric eyes seem to have a smaller axial growth rate in comparison with western eyes which suggests that we need a smaller under correction in the emmetropic IOL power to achieve the desired postoperative refraction.

The median decline in keratometry in 0–6, 6–18, and 18–60 month age groups was –0.083, –0.035, and 0 D/month, respectively. A similar change in corneal curvature studied in Caucasian population by Capozzi *et al*.[5] revealed a rate of decline of –0.40 D/month in the first 6 months, –0.14 D/month in the second semester, and –0.08 D/month in the second year. According to Trivedi and Wilson,[9] while axial length elongation continues beyond the first year of life, keratometry stabilizes by 6 months of age. The Indian eyes have a lower rate of keratometry change in comparison with western eyes.

The mean refractive spherical equivalent reduced from 6.112 ± 2.529 to 4.394 ± 2.073 D with a median decline in mean refractive spherical equivalent in 0–6, 6–18, and 18–60 month age groups were –0.416, –0.25, and –0.13 D/month, respectively. There was a significant correlation between the rate of change in axial length and rate of change in mean refractive spherical equivalent. The myopic shifts in pseudophakic eyes are

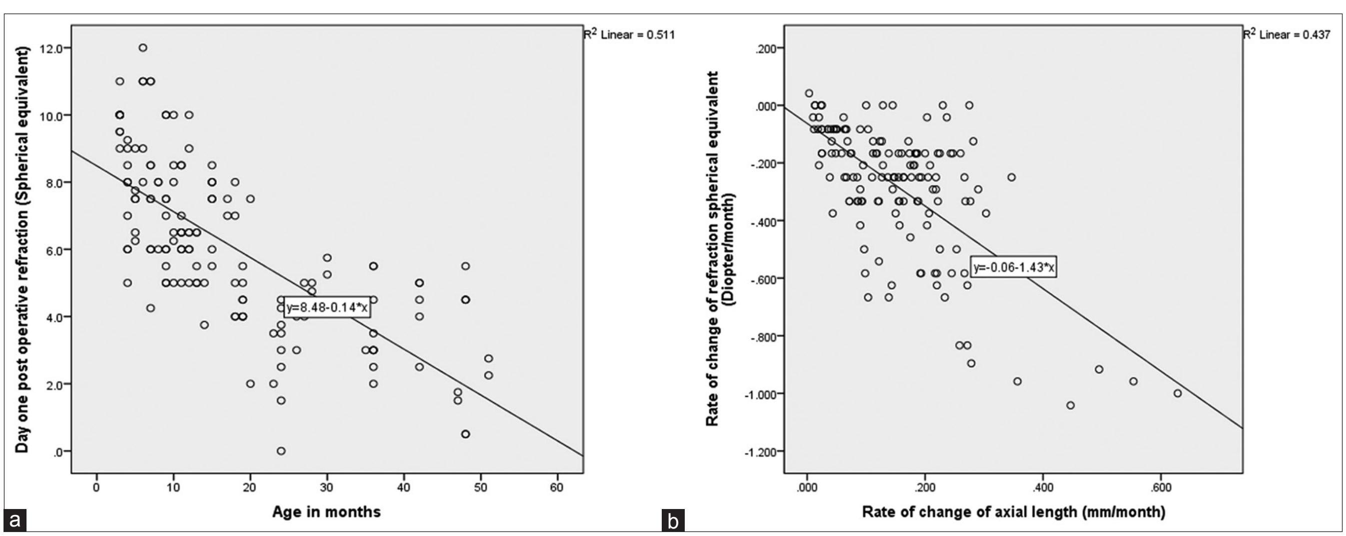

Figure 3: (a) Comparison of mean refractive spherical equivalent changes with time between different age groups. (b) Correlation between rate of change in axial length and rate of change in mean refractive spherical equivalent

expected to be greater than those observed in normal eyes even if the axial growth follows the normal pattern. This increased myopic shift probably occurs because in the developing phakic eye, progressive flattening of the crystalline lens reduces the refractive consequences of the axial elongation.[10] A study done by Sminia *et al*.[11] found no difference in the rate of axial length growth in between the operated eyes and fellow nonoperated eyes in unilateral pediatric cataract patients but a larger myopic shift was found in the operated eye.

None of the pseudophakic eyes in our study had a significant postoperative complication and none of the eyes required any form of resurgery in the 6-month follow-up. In the infant aphakia treatment study,[8] in 5-year follow-up, the pseudophakic eye had more postoperative complications in comparison with the aphakic eyes. This difference in the rate of postoperative complication in our studies can be because of the difference in the mean follow-up period after cataract surgery.

The limitations of our study were that the follow-up period was only 6 months. Secondly, because of the hospital being a tertiary care referral centre, there may be a bias of clustering of more severe and advanced disease. Furthermore, the axial length measurements were made with a contact A-scan (reading with maximum anterior chamber depth).[6]

A study done by Dahan and Drusedau[12] suggested undercorrection for the IOL power according to age was 20% for age < 2 years and 10% for age 2–8 years and the suggested IOL powers according to axial length were 21 mm –22.0 D, 20 mm –24.0 D, 19 mm –26.0 D, 18 mm –27.0 D, and 17 mm –28.0 D. This suggested that undercorrection does not corroborate with the axial length growth and the target refraction required for age.[13] Enyedi *et al*. reported a mean myopic shift in age groups 0–2 years, 2–6 years, 6–8 years, and >8 years was –3 D, –1.5 D, –1.8 D, and –0.37 D, respectively.[14] This rule was validated by Sachdeva *et al*.[15] McClatchey and Parks calculated the theoretic long-term refractive effects of pseudophakia in a large group of aphakic eyes with long-term follow-up and predicted a 6.6 D mean myopic shift (range, 36.3–2.9) over a mean follow-up of 11 years. Children aged 2 years and under at the time of surgery had a significantly greater predicted myopic shift and a greater variance in the predicted refractive change than those >2 years at the time of surgery.[16,17]

Conclusion

We advocate reduced amount of undercorrection in calculated emmetropic IOL power based on our clinical experience that Indian pediatric eyes have most of the axial length growth and keratometry stabilization in first 2 years and comparatively a lesser myopic shift with increasing age after surgery. A further long-term study is needed to recommend the required undercorrection.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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