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Original Article

Ophthalmology Section

A Study on Range of Near Visual Acuity in Children with Pseudophakia

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ABSTRACT

Introduction: Accommodation is the ability to see over a range of distances by changing the power of the natural lens. With cataract surgery, this ability is partially or completely abolished. Apparent accommodation or pseudo-accommodation is the potential of pseudophakic eyes to sustain a good amount of near vision.

Aim: To measure near vision in children with pseudophakia unaided, with distance vision correction alone (mono focal lens) in-situ and to measure the minimum near add (bifocal near segment power) required to read 1M (normal reading print size) at 30 cm and 40 cm.

Materials and Methods: A cross-sectional study was conducted among children between 5-15 years of age with pseudophakia. Vision assessment was done using Lea symbol chart, at 3 metres for distance and at 30 cm and 40 cm for near. Near vision assessment was done unaided and with distant vision correction alone in place. Minimum spherical power needed to read 1M and child's class textbooks were also assessed.

Results: Sixty-four children were included in the study. Mean age was 10.5 (±3.12) years. Refractive status showed spherical power ranging from -7.00 DS to +1.00 DS (-0.8 Mean, (±1.33 SD), astigmatism ranging from -4.50 DC to +3.00 DC (-1.29 mean, ±1.37 SD). Unaided near vision assessment showed that 41 (64%) could read <2M at 30 cm. Nine children could read 1M at 30 cm and three children could read 1M at 40 cm with distant vision correction alone in place.

Conclusion: Sixteen (25%) children in our study were independent of spectacles for reading 1M at a reading distance of 30 cm. Nine children (14.1%) read 1M at 30 cm with monofocal spectacles. Twenty-three children (35.9%) had good functional near vision and did not require any add for near work. Forty-six children (71.8%) required only 2 D or less near add for their classwork at 30 cm. Thus, monofocal or reduced near add can give these children a better quality of vision.

Keywords: Paediatric pseudophakia, Pseudoaccommodation, Retained accommodation

INTRODUCTION

Accommodation is the ability to see the near, over a range of distances, by changing the power of the natural lens [1-3]. The dioptric power of the eye changes as the anterior and posterior curvatures of the crystalline lens change due to contraction of the ciliary muscles. Apart from forward movement of the lens iris diaphragm, size of the pupil and intrinsic properties of the lens are factors that may be responsible for accommodation [2-4]. With cataract surgery, this ability is partially or completely abolished. Apparent accommodation or pseudo-accommodation is the potential of pseudophakic eyes to sustain a good amount of near vision. Various factors like astigmatism, depth of focus and forward movement of the Intraocular Lens (IOL) due to contraction of the ciliary body are thought to contribute to this phenomenon [5-11].

Loss of accommodation after cataract surgery, hence the need for spectacles to focus at near, has popularised the use of Multifocal Intraocular Lens (MF-IOL) in adults. These lenses focus on multiple foci simultaneously, thus requires neuroadaptation to focus on the object of interest. These adaptations to focus on the image of interest and the glare produced by the diffractive rings in MF-IOL can be disturbing. Pseudoaccommodation in adults has been studied [6,8,9]. However, this ability has not been explored in children.

The purpose of this study was to measure near vision in children with pseudophakia, unaided and with distance vision correction alone (monofocal) in place. The other objectives were to measure minimum near add (bifocal segment power) required to read 1M at 30 cm and 40 cm in children with pseudophakia and to assess the functional near vision in these children by assessing the ability to read their own class texts, both in English and in the local language.

MATERIALS AND METHODS

A cross-sectional study was conducted over a period of 3 months, from February 2017 to April 2017 in a tertiary care teaching eye hospital after obtaining approval from the Institutional Review Board (IRB min no: 9854). Children between the ages of 5-15 years with unilateral/bilateral pseudophakia having unifocal IOL were included in the study, after obtaining written informed consent from every parent and assent from all children above 8 years of age. Mentally challenged children and children who could not read Tamil or English were excluded. In children with bilateral pseudophakia, right eye parameters were taken for analysis to maintain uniformity and to avoid bias. A study by Lesiewska-Junk H and Kaluzny J, reported that the mean amplitude of accommodation was 4.4 D (±1.76 SD) [12]. Using this information, the sample size was calculated to be 48 with a precision of 0.5 at 95% confidence levels.

A subjective and objective refraction was done by a trained pediatric optometrist and Duochrome test was performed to confirm the spherical power. Spherical and cylindrical powers, as well as the axis, were noted. The cylindrical power was noted as Against The Rule (ATR) or With The Rule (WTR) astigmatism. Lea symbols were used for both distant and near vision assessment for uniformity of vision documentation in log Minimum Angle of Resolution (MAR). Distance vision assessment was done at 3 meters. Near vision was assessed at 30 cm and 40 cm using M notation. Near vision assessment was done unaided, with the child's spectacles and with distant vision correction alone in place. Minimum spherical power needed to read 1M, normal reading print size, (0.4 decimal) was assessed using near add starting at 1 diopter (D) increasing 0.5 D up to 3 D. Functional near vision was assessed by checking

the child's ability to read class text in English and Tamil. This was done with distant vision correction alone as well as with corrections ranging from 1 D to 3 D.

STATISTICAL ANALYSIS

Descriptive statistics such as mean, standard deviation, median (IQR) were used to handle quantitative variables like age and refractive status. For qualitative data, the number of patients and percentage were presented. The chi-square test was applied to the data. All tests were two sided at α=0.05 level of significance. All statistical analysis was done using SPSS software (version 21.0; SPSS Inc., Chicago, IL).

RESULTS

Sixty-four children with pseudophakia who fulfilled the criteria were included in the study. All participants were from India, and their demographic data are shown in [Table/Fig-1]. All 47 children with spectacles had standard bifocals with +3.00 D near add for reading. The range of near vision at 30 cm and 40 cm unaided with patient spectacles, and with distant vision correction alone in-situ is shown in [Table/Fig-2,3]. Range of spherical power required reading 1M at 30 cm and 40 cm is shown in [Table/Fig-4].

Variable			n (%)
Age (years)	Mean age (SD)		10.5 (±3.12)
	5-10		20 (31.2%)
	11-15		44 (68.8%)
Gender	Male		45 (70.3%)
	Female		19 (29.7%)
Family monthly income (INR)	<5000		32 (50%)
	>5000-10000		29 (45.3%)
	>10000		3 (4.7%)
Laterality of pseudophakic eye	Bilateral		29 (45.3%)
	Unilateral	Right eye	18 (29%)
		Left eye	17 (26.6%)

[Table/Fig-1]: Demographic features of study participants (n=64).

	1 M	1.25 M	1.6 M	2 M	>2 M
Unaided (n=64)	16	15	10	10	13
Patient's spectacles (n=47)	25	5	9	3	5
Distant vision correction alone (monofocal) (n=64)	9	11	15	17	12

[Table/Fig-2]: Range of near vision in children with pseudophakia at 30 cm.

	1 M	1.25 M	1.6 M	2 M	>2 M
Unaided (n=64)	7	11	15	12	19
Patient's spectacles (n=47)	18	7	7	5	10
Distant vision correction alone (monofocal) (n=64)	3	8	20	14	19

[Table/Fig-3]: Range of near vision in children with pseudophakia at 40 cm.

Near add in Diopter (D)	30 cm (n=58)*	40 cm (n=58)*
Nil near add (monofocal)	9	3
+1.00 D	12	16
+1.50 D	6	11
+2.00 D	13	10
> +2.00 D	18	18

[Table/Fig-4]: Range of spherical power required to read 1M.
*Six children could not read 1 M even with 3 D

The status of refractive error in the 64 children are shown in [Table/Fig-5]. This showed spherical power ranging from -7.00 sphere in diopter (DS) to +1.00 DS (-0.8 mean, ±1.33 SD), astigmatism ranging from -4.50 cylinder in diopter (DC) to +3.00 DC (-1.29 mean, ±1.37 SD), spherical equivalent ranging from -4.50D to +1.25D (-1.8 mean, ±1.01 SD). Fourteen children had simple myopic astigmatism, while 15 had WTR astigmatism and 17 had ATR astigmatism. The spherical equivalent of children who could read 1M at 30 cm with distant vision correction alone ranged from -0.75 to -3.75. Among those who could read 1M at both 30 cm and 40 cm had a spherical equivalent range from -2 to -3.75 [Table/Fig-6]. Near add required to read class text in English and Tamil along with distant vision correction alone at 30 cm and 40 cm is shown in [Table/Fig-7]. Using a range of near add, there was difference in the ability to read English and Tamil at 30 cm and 40 cm using distant vision correction alone in place (p<0.001).

Types of refractive errors	n (%)
Simple myopia	3 (4.7)
Simple myopic astigmatism	14 (21.8)
Compound myopic astigmatism	30 (46.9)
Hypermetropia	0
Simple hypermetropic astigmatism	3 (4.7)
Compound hypermetropic astigmatism	0
Mixed astigmatism	8 (12.5)
Not accepting lens	6 (9.4)

[Table/Fig-5]: Refractive status of children (n=64).

No.	Laterality	D.sph	D.cyl	Axis	Sph.eq	Distance (cm)
1	RE	-2.00	-1.00	160	-2.50	30 and 40
2	RE	-1.50	-1.50	180	-2.25	30
3	RE	-2.00	-3.50	080	-3.75	30 and 40
4	RE	-2.00	0	0	-2.00	30 and 40
5	RE	0	-1.50	160	-0.75	30
6	RE	-0.50	-1.00	090	-1.00	30
7	LE	0	-2.50	120	-1.25	30
8	RE	+1.00	-4.00	170	-1.00	30
9	RE	-2.00	-2.00	070	-3.00	30

[Table/Fig-6]: Refractive error in children who could read 1M with monofocal distant vision correction.
D.sph=sphere in diopter; D.cyl=cylinder in diopter; Sph.eq=spherical equivalent

Power of near vision segment	English text at 30 cm	Tamil text at 30 cm	English text at 40 cm	Tamil text at 40 cm
Without any near add	23	23	20	20
+1.00D	8	9	11	11
+1.50D	8	9	9	9
+2.00D	7	6	7	7
> +2.00D	18	17	17	17

[Table/Fig-7]: Near add required to read class textbook (n=64).
Chi-square p<0.001

DISCUSSION

In the present study, authors did near vision assessment in children with pseudophakia at 30 cm, the standard reading distance, and at 40 cm as children usually carry out near vision activities at 40 cm. Unaided near vision assessment in these children showed that 16 (25%) children could read 1M (normal print size) and 41 children (64%) could read <2M at 30 cm [Table/Fig-2]. This indicates that the majority of children could handle their near activities without spectacles. Considering that most children had post-operative refraction as myopia or myopic astigmatism. The present authors placed distant vision correction in-situ and assessed the near vision. Myopia and myopic astigmatism can contribute to good unaided near vision [7,8]. To negate this effect, authors placed distant vision correction in-situ, thus shifting the farpoint from in front of the eye to infinity. In spite of the distant vision correction in-situ, nine (14%) could read 1M at 30 cm, probably indicating their ability to

pseudo accommodate even up to 3 diopters. Forty children (62.5%) required only 2 diopters or less to read 1M at 30 cm suggesting the possibility of 1 diopter of pseudo accommodation [Table/Fig-4].

Unaided near vision showed that 16 (25%) children could read 1M (normal print size) at 30 cm. Fifteen (23.4%) children could read 1.25M and 10 (15.6%) were able to read 1.6M unaided at 30 cm. Hence near vision assessment without spectacle correction showed that 41 (64%) children could read <2M at 30 cm [Table/Fig-2].

Six children could not read 1M even with +3 D near add [Table/Fig-4] necessitating need for higher near add/low vision aids for reading normal print size. Unaided, 16 (25%) children could read 1M at 30 cm as compared to 7 (10.9%) at 40 cm. With distant vision correction alone in-situ, 9 (14.1%) children could read 1M at 30 cm as compared to 3 (4.6%) at 40 cm. With loss of accommodation after cataract surgery, the present authors expect reduced near vision at a closer distance. However, the present study showed better vision at 30 cm as compared to 40 cm. This showed that fonts were read better at a closer distance (30 cm) suggesting that linear magnification might be the reason for this.

The present authors assessed various near vision adds required to read normal print size at 30 cm and 40 cm. The present authors did this to reduce the standard +3D add prescribed in pseudophakia, to reduce image jump. This could also indirectly give an idea of the retained accommodation in these children. At 30 cm, when a +3D add was expected, 40 (62.5%) could read 1M with <2D. Functional near vision assessment was done by checking the ability of the child to read their own class textbook. One-third of children could read their class textbooks without spectacles.

Only a few studies are measuring the range of near visual acuity in children with pseudophakia [12,13]. Lesiewska-Junk H and Kaluzny J, reported on IOL movement and accommodation in young patients, and showed that mean anterior movement of the IOL was 0.42 mm at near and mean pseudo-accommodation amplitude was 4.50 diopter [12]. This study suggested that movement of posterior chamber IOL in young patients may be one reason they attain good near vision without near vision correction [12]. Nihalani BR and Vanderveen DK, assessed the uncorrected visual acuity in children with pseudophakia with MF-IOL [13]. Among 41 eyes included in this study, 20 had good visual acuity at distance and near, 11 had good visual acuity at distance, and 6 had good visual acuity at near. The study also mentions that higher order of aberration could be a possibility in the ability to read near [13]. This is the first study looking into the range of near visual acuity in pediatric population with pseudophakia.

Limitation(s)

Limitation of the present study was that physiological factors like pupil size, anterior chamber depth nor change in the position of the IOL which might have an effect on the ability to read at near were not assessed. Majority of the study patients had myopia or myopic astigmatism and were expected to read near unaided. Interestingly, the present authors noted that 9 children could read near well, even with distant correction in place suggesting the possibility of certain amount of retained accommodation. Future studies could look into the physiological factors responsible for retained accommodation as well as to measure amplitude of accommodation in children with pseudophakia. This would help gain a better understanding of the advantages and disadvantages of multifocal intraocular lenses.

CONCLUSION(S)

Nine children from the presnt study could read 1M at 30 cm with monofocal spectacles. Monofocal spectacles can give children a better quality of vision. Forty-six children with pseudophakia included in the study had good functional near vision. Assuming certain amount of retained accommodation, a meticulous near vision assessment should be done for children with pseudophakia and required near add alone needs to be prescribed.

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