Original Article

Ocular auto-stimulation and its morbidity in stage 5 retinopathy of prematurity

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Purpose: To evaluate the characteristics and morbidity due to ocular auto-stimulation (OAS) in stage 5 Retinopathy of Prematurity (ROP). **Methods:** Stage 5 ROP cases presenting to ROP clinic of a tertiary care centre from January 2017 to December 2017 were recruited. Eye-pressing was elicited on history from parents and categorized as infrequent (performed <50% of waking time) or frequent (≥50% of time). B-scan ultrasonography was performed for configuration of retinal detachment (open or closed funnel). Keratometry was performed in eyes undergoing vitrectomy under general anaesthesia using automated hand-held keratometer. The outcome measures were the presence and characteristics of OAS, enophthalmos, corneal opacity and keratometry values. **Results:** Out of 93 eyes of 49 babies, 78.5% (n = 73) had OAS. Gestational age, birth weight, sex, retinal funnel configuration, and visual function did not significantly affect OAS. However, post-conceptional age was significantly greater in eyes with OAS (95% CI: 63.1 to 69.9 weeks) than those without OAS (95% CI: 52.4 to 63.4 weeks) (P = 0.018). OAS occurred frequently in 32.8% (n = 24/73) eyes, more commonly in eyes with light followability. Keratometry did not differ significantly with the presence of OAS (P = 0.88). Enophthalmos, corneal opacity, posterior synechiae were noted in 79.5% (58/73), 21.9% (16/73), and 28.8% (21/73) eyes with OAS, respectively. Enophthalmos occurred significantly in eyes with OAS (P = 0.001), while corneal opacity and posterior synechiae did not (P = 0.071 and 0.91, respectively). **Conclusion:** OAS and its resultant morbidity are common occurrences in stage 5 ROP. The post-conceptional age and residual visual function may govern the characteristics of OAS.

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Stereotyped behaviors like eye pressing and eye poking are often seen in visually impaired children.[1,2] Eye pressing is a self-stimulatory behavior which occurs in cases of severe bilateral visual loss.[3] It is predominantly seen in cases with peripheral visual loss due to retinal disorders. Prolonged pressure on the globe may produce action potentials in the retina and/or optic nerve which may travel to the intact central visual system and are perceived as phosphenes.[3] On the other hand, eye poking is a self-injurious behavior which occurs in cases of severe mental disability with or without the presence of visual impairment.[4]

These stereotyped behaviors have often been clubbed as the oculodigital phenomenon or ocular auto-stimulation (OAS).[1,3,5] These have been reported in various ocular disorders such as Leber's congenital amaurosis, stage 5 retinopathy of prematurity (ROP), bilateral corneal leucoma, bilateral dense cataract, congenital optic atrophy, or aplasia/hypoplasia.[3-6]

There is a paucity of literature on OAS in ROP. No clear consensus exists on the relation of these stereotypes with the amount of visual impairment, age of the child, onset of visual impairment, and type of retinal abnormality. The consequences of such stereotypes have not been reported in depth previously. Only a few anecdotal case reports exist on the ocular abnormalities arising out of oculodigital phenomenon. Also, most of these pertain to conditions other than ROP.[6-10]

The aim of this study is to determine the prevalence, characteristics, and ocular consequences of OAS in cases with stage 5 ROP.

Methods

In this cross-sectional observational study, cases with stage 5 ROP presenting to the ROP clinic at a tertiary care center in North India from January 2017 to December 2017 were recruited. The study adhered to the tenets of the Declaration of Helsinki. All cases were out-born babies referred from elsewhere for management. Parents/caregivers gave consent before recruitment of the cases in the study.

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The inclusion criteria were stage 5 ROP cases and parents willing for participation in the study. Cases in which there was evidence of other ocular pathologies like microphthalmos, retinal dystrophies/degeneration, and angle closure glaucoma were excluded from the study.

The demographic details, birth history, systemic risk factors for ROP, previous ocular, and systemic treatment details were collected. History of eye-pressing or eye-poking was elicited from parents. The frequency of OAS was determined based on the amount of waking hours spent doing the stereotyped behavior. It was classified into none, occasional (<50% of the waking time), or frequent (>50% of the waking time). The method of eye-pressing or poking was asked for from the parents (thumb or finger or knuckles).

The examination included visual acuity assessment (follows light or does not follow light), documentation of the stereotype behavior and its details, direct torchlight peri-ocular and anterior segment examination, and posterior segment evaluation on indirect ophthalmoscopy (retinal detachment). A note was made of the presence of peri-orbital bruises/scars/skin darkening, deep superior sulcus/deep set eyes, corneal opacity/ulcer/epithelial defect/thinning with ectasia/healed hydrops, posterior synechiae, and cataract.

All cases underwent fundus imaging using paediatric wide field fundus camera (RetCam, Clarity, USA) and ultrasound B-scan (VuMax, 10 MHz, Sonomed) to determine the retinal funnel status (whether open or closed anteriorly and posteriorly). In cases undergoing vitrectomy for stage 5 ROP, keratometry was recorded using hand-held automated refractometer/keratometer (HandyRef-K, Nidek Co. Ltd., Japan) just prior to initiating surgery. All readings were obtained by a single observer. Two readings were recorded for each eye after optimal alignment and pupil centration. Mean of the obtained readings was taken as final keratometry for both steep and flat axis.

The data was recorded on a predesigned sheet and entered in an Excel spreadsheet. The statistical analysis was done using SPSS software for Windows. For descriptive purposes, non-parametric data were expressed as median (range), parametric qualitative data as a percentage and quantitative data as the mean ± standard deviation (SD). The Chi-square test and Fischer exact test were used for comparing qualitative data; for parametric quantitative data, one-way analysis of variance (ANOVA) was used to compare intergroup means; Kruskal–Wallis and Mann–Whitney tests were used for non-parametric quantitative data.

Results

A total of 93 eyes of 49 children with stage 5 ROP were recruited during the study period. The mean gestational age (GA) and birth weight (BW) of the infants were 30.1 ± 2.6 weeks (range, 26–38 weeks) and 1340 ± 390 g (range, 700–2500 g), respectively. The mean post-conceptional age (PCA) at the time of recruitment was 64.7 ± 14.5 weeks (range, 38–107 weeks). Males constituted 53.1% (26/49) of the children.

Retinal detachment on USG B scan was anteriorly and posteriorly open (OO) funnel, anteriorly open posteriorly closed (OC) funnel, and anteriorly and posteriorly closed (CC) funnel in 12.9% (12/93), 55.9% (52/93), and 31.2% (29/93) of the eyes, respectively. On assessing the visual function, only 28.6% (23/93) of the eyes followed light. Keratometry readings were recorded for 45 eyes of 23 children who underwent ROP surgery. The mean steep and flat keratometry readings were 53.5 ± 2.7 D (range, 49.7–62.7D) and 51.0 ± 2.5D (range, 46.7–56.0 D), respectively. The steep and flat keratometry readings were correlated with respect to the GA, PCA, and BW. A weak negative correlation was noted for these parameters [Table 1]. Also, the distribution of keratometry was not different between males and females [Table 1].

OAS was present in 78.5% (73/93) of the eyes. In 90.4% of these eyes (66/73), knuckles were used for eye pressing while in the rest index fingers were used for poking the eye. OAS was seen to occur frequently (≥50% of the waking time) in 32.8% (24/73) eyes.

The variables GA, BW, sex, retinal funnel configuration, visual function, and keratometry did not significantly affect the presence of OAS [Table 2]. However, the PCA was greater in eyes with OAS (66.5 ± 14.7 weeks; 95% CI: 63.1 to 69.9 weeks) than those without OAS (57.9 ± 11.8 weeks; 95% CI: 52.4 to 63.4 weeks) with a statistically significant difference ($P = 0.018$).

On comparing the eyes with frequent and infrequent OAS, the PCA, mean keratometry (both steep and flat) and the retinal funnel configuration did not differ significantly [Table 3]. A greater percentage of eyes followed light among the frequent OAS group (45.8%, 11/24) than the infrequent OAS group (20.4%, 10/49) with a statistically significant difference in distribution ($P = 0.024$).

In OO, OC, and CC funnel categories, OAS was noted in 83.3% (10/12), 82.7% (43/52), and 68.9% (20/29) of the eyes respectively with no statistically significant difference between the categories ($P = 0.32$). The mean steep and flat keratometry readings were 52.1 ± 1.7 D and 49.8 ± 3.24 D respectively in OO group (n = 4), 54.2 ± 2.8 D and 51.7 ± 2.1 D respectively in OC group (n = 29), and 52.3 ± 2.1 D and 49.9 ± 2.9 D, respectively in CC group (n = 12). Due to a low number of eyes with OO group (n = 4), keratometry could only be compared between the OC and CC group. The steep and flat keratometry readings were significantly greater in the OC group than in CC group ($P = 0.04$ and 0.03, respectively).

Table 1: Comparison between keratometry and various parameters in preterm babies with stage 5 Retinopathy of Prematurity

Variable	Steep keratometry	Flat keratometry
GA		
Pearson correlation coefficient	-0.01	-0.05
P	0.93	0.7
PCA		
Pearson correlation coefficient	-0.26	-0.17
P	0.08	0.25
BW		
Pearson correlation coefficient	-0.31	-0.35
P	0.03	0.017
Sex		
P (two sample t-test)	0.48	0.82

GA=Gestational age; PCA=Post-conceptional age; BW=Birth weight

Table 2: Characteristics of cases of stage 5 Retinopathy of Prematurity with or without ocular auto-stimulation

Variable	OAS absent	OAS present	*P*	Statistical test
Sample size (*n*)	20	73		
GA (weeks)	30.0±2.6	30.1±2.6	0.82	Two sample *t*- test
BW (grams)	1200±400	1360±390	0.22	Two sample *t*- test
PCA (weeks)	57.9±11.8	66.5±14.7	0.018	Two sample *t*- test
Sex:male, female (*n*)	11, 9	38, 35	0.81	Pearson χ^2 *t*est
Retinal funnel: OO, OC, CC (*n*)	2, 9, 9	10, 43, 20	0.32	Fisher's exact *t*ext
Visual function: FL, NFL (*n*)	2, 18	21, 52	0.07	Fisher's exact *t*ext
Steep keratometry (D; *n*)	53.4±1.4; 11 eyes	53.5±3.0; 34 eyes	0.88	Two sample *t*- test
Flat keratometry (D; *n*)	51.2±1.8; 11 eyes	51.0±2.7; 34 eyes	0.82	Two sample *t*- test

OAS=Ocular auto-stimulation; GA=Gestational age; BW=Birth weight; PCA=Post-conceptional age; OO=Open-open retinal funnel; OC=Open-closed retinal funnel; CC=Closed-closed retinal funnel; FL=Follows light; NFL=Not follows light

Table 3: Characteristics of cases of stage 5 Retinopathy of Prematurity depending upon the frequency of ocular auto-stimulation

Variable	OAS infrequent	OAS frequent	*P*	Statistical test
Sample size (*n*)	49	24		
PCA (weeks)	64.6±14.2	70.5±15.1	0.29	ANOVA
Retinal funnel: OO, OC, CC (*n*)	6, 28, 15	4, 15, 5	0.54	Fisher's exact text
Visual function: FL, NFL (*n*)	10, 39	11, 13	0.024	Pearson χ^2 test
Steep keratometry (D; *n*)	53.5±2.8; 22 eyes	53.6±3.4; 12 eyes	0.98	ANOVA
Flat keratometry (D; *n*)	50.9±2.7; 22 eyes	51.1±2.8; 12 eyes	0.97	ANOVA

OAS=Ocular auto-stimulation; PCA=Post-conceptional age; OO=Open-open retinal funnel; OC=Open-closed retinal funnel; CC=Closed-closed retinal funnel; FL=Follows light; NFL=Not follows light; ANOVA=Analysis of variance

Enophthalmos was noted in 79.5% (58/73) of eyes with OAS and 5% (1/20) of eyes without OAS (P = 0.001). On subgroup analysis, enophthalmos was more frequently observed in frequent OAS group (100%) than infrequent OAS group (69.4%). Corneal opacity was seen in 21.9% (16/73) eyes with OAS and 5% (1/20) eyes without OAS (P = 0.071). The corneal opacity noted in all cases was maculo-leucomatous in nature and central in location. Posterior synechiae were observed in 28.8% (21/73) eyes with OAS and 30% (6/20) eyes without OAS (P = 0.91). Corneal ulcer, corneal hydrops, and cataract were not seen in any case.

Discussion

This study highlights that OAS was commonly observed in stage 5 ROP patients and contributed significantly to ocular morbidity. We describe the characteristics and consequences of such mannerism. A few comprehensive studies exist on the evaluation of OAS in children with blindness or severe visual impairment.[2-4]

Jan *et al*. studied various forms of visual auto-stimulation and speculated on its pathophysiology. The study included 619 patients with blindness of which 14.9% cases had OAS.[3] All cases with congenital or acquired blindness were included in this study but the authors did not elaborate the type of retinal disorders in these cases. Certain stereotyped mannerisms like body-rocking, eye-pressing, and light-gazing were commonly exhibited among severe visually impaired children. The authors also observed that children with retinal disorders pressed eyes vigorously, while those with optic nerve disorders did not press their eyes. This explains the marked contrast observed in the incidence of OAS when compared to our study (14.9% vs. 78.5%), which included cases of ROP alone.

Jan *et al*. had reported that the age, onset of visual impairment, residual visual function, type of ocular abnormality, and additional handicaps played an important role in OAS (eye-pressing) presentation.[3] The mannerism appeared between 8 to 10 months of age and decreased in frequency as the children grew in age in their study. We also noted a similar trend, wherein the post-natal age of patients with OAS was between 33 to 40 weeks i.e., 8 to 10 months (GA of 30 weeks, PCA of 63–70 weeks). We believe that OAS occurs only after a certain age, by which time the visual cortex should ideally have received meaningful visual information for development. When this does not happen due to diffuse retinal dysfunction, the unmet need of visual cortex manifests in the form of compensatory retinal/optic nerve stimulatory behavior in the form of eye-pressing initially. Later, this turns into a stereotyped behavior.

In contrast to the finding by Jan *et al*.[3], we did not find residual visual function and type of retinal funnel abnormality as significant determining factors for the manifestation of OAS (eye-pressing). However, the closed funnel group had the least mannerism of all (although statistically insignificant). Also, the presence of residual visual function affected the frequency of mannerism, with more frequent behavior in eyes with light followability. We believe that the occurrence of OAS may depend solely on the type of ocular abnormality (retinal/optic nerve), the extent of involvement (widespread dysfunction as in stage 5 disease), and the age of the child (above eight months of age). The frequency of the mannerism may then be decided

by factors such as residual visual function and presence of additional handicap.

In another study by Jan *et al*., the author reported that the severity of visual loss did not correlate with the frequency and severity of eye-poking.[4] In this study majority of the children (>80%) had cortical visual loss. The authors observed that the intensity of eye-poking increased with severity of mental disabilities. In contrast to the stimulatory eye-pressing behavior observed in cases with peripheral visual system dysfunction, eye-poking is a self-injurious behavior seen in cases secondary to central visual system abnormality. Consequences of eye-poking may be more profound such as bruising of the periocular skin, corneal scarring, corneal ulcer, and globe luxation.[4]

The mean keratometry at the mean post-conceptional age of 64 weeks or post-maturation age (above 40 weeks of normal gestation period) of 24 weeks/6 months was higher (mean steep K = 53.5D) as compared to the result reported previously in healthy infants at six months (around 47.6D).[11] This may be in accordance with the fact that the cornea tends to be steeper in preterm infants at birth. However, if it continues to remain steep later in life in these cases is not known from the literature. Although the development of corneal steepening and keratoconus has been reported in literature secondary to repetitive corneal micro-trauma from OAS,[7,9,10] we did not find any difference between steep and flat keratometry between eyes with OAS and those without OAS. Even the frequency of OAS did not affect the keratometry significantly. The sole parameter affecting the steepness of cornea was the retinal funnel status, with steeper cornea in open-closed funnel as compared to closed funnel group. From the reports of keratoconus development in stage 5 ROP blind or blind due to other causes[9,10,12] and from the keratometry results of our study, we propose that the corneal curvature is inherently steep in such eyes due to either preterm birth or due to the disease process itself. The presence of eye-pressing alone may not significantly affect the corneal curvature. However, as it is known that intense eye-poking may be associated with corneal changes; long-term studies are needed to determine the effect of eye-pressing on keratometry.

Similar to the corneal curvature, we did not find an increased incidence of corneal scarring and posterior synechiae formation with OAS. Rather, these may be a consequence of the anterior segment abnormalities commonly occurring in these eyes such as shallow anterior chamber, angle closure glaucoma and corneal decompensation. Presence of deep-set eyes was clearly a consequence of eye-pressing with a definite relation with the duration of stereotype. This may occur due to the bony orbital expansion and orbital fat atrophy secondary to chronic pressure on these structures. The enophthalmos poses cosmetic problems such as deep superior sulcus and narrow palpebral aperture (pseudoptosis). Facial asymmetry may also develop later in life. Although this may not affect these blind children, but may have a significant psychological effect on the caregivers.

Stage 5 ROP is an important cause of childhood blindness in the developing countries. Around 2900 preterm infants survive with visual impairment/blindness every year in India, mostly due to poor ROP screening practices.[13] Since greater than three-quarters of the stage 5 ROP babies had OAS in our study and out of these, three-quarters babies had ocular morbidity, the estimated burden of OAS and induced morbidity will be enormous. Whether OAS leads to ocular structural changes or not, these blinding mannerisms pose a significant reason for anxiety and distress to the caregivers. Parents often do not understand the reason behind such stereotypes and often fail in preventing these repetitive acts. Moreover, these stereotypes are often seen as a social stigma and add to the emotional burden of the care-givers.

OAS is difficult to stop and parents need to be counseled that it cannot not be prevented by punishment and physical restraints.[3] It is thought that OAS occurs most often when the child is tired or bored.[3] By physical restriction, the child may become more anxious and the mannerism may tend to worsen. Instead, the parents should try to introduce activities to keep their hands occupied.

The present study had a few limitations. Being a cross-sectional evaluation, the long-term effects of chronic OAS on keratometry and other corneal parameters may have been missed and needs to be studied prospectively. The measurement of OAS was based on the time spent performing this mannerism, which may seem a crude way, but other objective parameters are difficult to measure. The enophthalmos could not be measured objectively with an exophthalmometer due to lack of cooperation in these small children. The effect of mental handicap was not evaluated which has been previously described as a significant deciding factor for the frequency of eye-pressing and occurrence of eye-poking.[4] Also, the effect of behavioral adaptations and post vitrectomy change in the visual function and OAS can be studied in future.

Conclusion

To conclude, the study highlights the characteristics and predicting factors of OAS in stage 5 ROP. Although OAS occurs so commonly in stage 5 ROP babies, yet it is often neglected. Not only does it cause a significant ocular morbidity in a majority of the cases, it may also add to the anxiety of the caregivers. In fact, the psychological and social impact of OAS to the child and parents may be much beyond ocular disability. There is a need to increase the awareness about the disease, promote rehabilitation of these patients, and properly counsel the parents.

Disclosures

A part of the study was presented as E-poster at 4th World Congress of Paediatric Ophthalmology and Strabismus (WCPOS) held in 2017 at Hyderabad, India.

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Conflicts of interest

There are no conflicts of interest.

References

1. Molloy A, Rowe FJ. Manneristic behaviors of visually impaired children. Strabismus 2011;19:77-84.
2. Fazzi E, Lanners J, Danova S, Ferrarri-Ginevra O, Gheza C, Luparia A, *et al*. Stereotyped behaviours in blind children. Brain Dev 1999;21:522-8.

3. Jan JE, Freeman RD, McCormick AQ, Scott EP, Robertson WD, Newman DE. Eye-pressing by visually impaired children. Dev Med Child Neurol 25:755-62.
4. Jan JE, Good WV, Freeman RD, Espezel H. Eye-poking. Dev Med Child Neurol 1994;36:321-5.
5. Roy FH. Ocular autostimulation. Am J Ophthalmol 1967;63:1776-7.
6. Mansour AM, Reinecke RD. The pop eye phenomenon: An extreme form of the oculodigital phenomenon. J Clin Neuroophthalmol 1985;5:281-2.
7. Elder MJ. Leber congenital amaurosis and its association with keratoconus and keratoglobus. J Pediatr Ophthalmol Strabismus 1994;31:38-40.
8. Tarlan B, Kiratli H, Kılıç E, Utine E, Boduroğlu K. A case of 22q11.2 deletion syndrome with right microphthalmia and left corneal staphyloma. Ophthalmic Genet 2014;35:248-51.
9. Lorfel RS, Sugar HS. Keratoconus associated with retrolental fibroplasia. Ann Ophthalmol 1976;8:449-50.
10. Kogoleva LV, Pleskova AV. [Keratoconus in children with retinopathy of prematurity (clinical cases)]. Vestn Oftalmol 2012;128:32-4.
11. Asbell PA, Chiang B, Somers ME, Morgan KS. Keratometry in children. CLAO J Off Publ Contact Lens Assoc Ophthalmol Inc 1990;16:99-102.
12. Hittner HM, Rhodes LM, McPherson AR. Anterior segment abnormalities in cicatricial retinopathy of prematurity. Ophthalmology 1979;86:803-16.
13. Blencowe H, Moxon S, Gilbert C. Update on blindness due to retinopathy of prematurity globally and in India. Indian Pediatr 2016;53(Suppl 2):S89-92.