AN OBSERVATIONAL STUDY ON GRATING VISUAL ACUITY ASSESSMENT OF CHILDREN WITH DEVELOPMENTAL DELAY

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ABSTRACT

TITLE: *An observational study on Grating Acuity Assessment of Developmentally Delayed Children*

AIM: *To assess Grating Acuity of children aged 1 to 5 years with developmental delay after one year of visual skill training.*

METHODS: *Ten (8 male & 2 female) non-verbal children with developmental delay and visual complaints were selected for the study. LEA Gratings were administered to assess the Grating Acuity of the subjects twice at the interval of one year in a Vision Rehabilitation Centre of an Eye Hospital in India. These children were trained in visual skills for the period of one year and then assessed for the second time.*

RESULTS: *The mean age of the children is 2.8±1.31 years. A paired t-test was performed for Cycles Per Degree(CPD) measurement at the beginning and at the end of one year after training. It revealed a statistically significant improvement ($p<0.05$) in vision at the end of one year. There was a positive correlation between the baseline CPD measurement and one year post training measurement.*

CONCLUSION: *Grating Acuity of children aged 1 to 5 years with developmental delay after one year of visual skill training revealed improvement in vision except two children.*

KEYWORDS: *Developmental delay, Grating Acuity, Visual skill training*

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TITLE: An observational study on Grating Acuity Assessment of Developmentally Delayed Children

INTRODUCTION:

The Vision Rehabilitation Centres in India rehabilitate a large number of referrals with developmental delay and visual complaints. The common Ophthalmic & Neurological diagnosis among the referred children with developmental delay reveals Cortical Visual Impairment, Delayed Visual Maturation, Cerebral Palsy, Hypoxic Ischemic Injuries, Seizure Disorders or the combinations of the above. Snellen charts, Log MAR tests, LEA symbols & numbers, preferential looking are the common vision tests administered among young children. The visual acuity is measured as recognition acuity which cannot be used in evaluating infants and children with multiple impairments. Hence vision is measured with grating acuity tests as detection or discrimination acuity (Lea, 2012).This study used Lea Grating test as detection test.

Children aged 36 months and younger than 72 months were recommended to be screened annually or at least once using one of the best practice approaches (Cotter 2015). A study reveals that premature children with gestational age less than 37 weeks exhibit the risk of ocular morbidities which was examined and assessed through visual acuity testing with Lea symbols, anterior and posterior segment examination, refraction, orthoptic examination for strabismus, and ocular biometry (Goktas, Sener, Sanac, 2012) Assessment of visual deficits by using dice with different colors, size down to an edge of 4mm in low vision infants within the first year of life is beneficial to assess the infants with severe impairments as it is difficult to conduct visual acuity tests.

Preferential looking could be assessed with regard to the reaction of the infant to the dice (Rohrschneider, Brill, Bayer, Ahrens, 2010). Results of a study on visual acuity screening of preterm infants suggest that visual acuity is more correlated with age from conception than with age from birth. The Screening has to be carried out appropriately with acuity gratings for infants in post term age of the infant rather than the postnatal age (Dobson, Mayer,Lee1980).

An acuity assessment which combines Forced-choice preferential looking (FPL) and Operant preferential looking (OPL) was administered to test the acuity of infants in a study. A series of grey cards with grating targets of spatial frequencies were shown. The eye

movement patterns and behavior of the infant reveal whether the infant could see the gratings on each card or not. The acuity is estimated by the infant ability to see the higher spatial frequency (McDonald, Dobson, Sebris, Baitch,Varner,Teller,1985). In a research under laboratory setting, infants and children at risk for deficits in vision were assessed using grating acuity cards (Dobson,1983).

LEA grating acuity test was administered in a study to evaluate the relationship between the head posture and visual acuity of children with nystagmus. The tests were applied under two occasions i.e. with and without proper head posture. The study concludes that visual responses are affected with the pursuit of traditional postural alignment (da Costa, Lopes, Nakanami ,2014). A large cohort was conducted for children with cerebral visual impairment on contributing factors to Visually Evoked Potential (VEP), Grating Acuity Deficit (GAD) and inter- ocular acuity difference. The results indicated variable severity of VEP, GAD was found with CVI, more than half of the children with severe deficits. Children older to them and those are under anti-seizure therapy showed high risk for larger deficits (Cavascan, Salamao, Sacai, Pereira, Rocha, Berezovsky, 2014).

A study was conducted for children with different types of spastic cerebral palsy on grating visual acuity. Acuity was measured using psychophysical procedure with Teller Acuity Cards (TAC). The study concludes electrophysiological procedure is better than behavioral visual acuity tests in children with cerebral palsy (Costa,Ventura, 2012). Grating acuity along with intraocular acuity differences was determined in a study using VEP technique. The study insisted on incorporating the norms for grating and intraocular acuities in clinical practice for diagnosis of visual status of infants and preverbal children (Salomão, Ejzenbaum, Berezovsky, Sacai, Pereira, 2008).

The common hidden problem of children with disability is visual processing disorders which may affect the development and learning of the child, requires early diagnosis, intervention of trans-disciplinary team (Lea, 2009). The team comprises of Physicians, teachers, orthoptists, therapists, psychologists, vision rehabilitation optometrists, early intervention and rehabilitation professionals.

Hence it is extremely important to assess the grating acuity as it is very difficult to arrive at a concrete result with traditional clinical vision charts. The grating acuity results will provide better ideas to the Rehabilitation professionals, Educators and Parents in designing the rehabilitation programs and also in adapting the environment appropriate to the children.

METHODS AND MATERIALS:

Ten children who were referred to a Vision Rehabilitation Centre at Frontline Eye Hospital in Chennai were selected. All of them have developmental delay & visual complaints. The age of the group is from 1 – 5 years and it consists of 8 boys and 2 girls. The mean age of the children is 2.8±1.31 years. The children were diagnosed to have conditions like Cerebral Palsy, Hypoxic Ischemic Injuries, Seizure disorders or combinations of these. The visual diagnosis revealed delayed visual maturation or cortical visual impairment. The visual characteristics observed were primarily very poor oculo motor skills and absence of meaningful vision & social smile.

Fig 1: Lea Grating Paddles

Source: Lea Grating Paddles

Fig 2: Grating Acuity Evaluation

Source: Frontline Eye Hospital, Chennai

Lea Gratings were used to test the acuity of children. In the grating acuity test, the child detects the presence of parallel lines of decreasing width which is easier than identifying letters or numbers. As per the GOOD – LITE's test instruction flier, the gratings are defined by the frequency i.e., the number of pairs of black and white stripes or cycles, within one degree of visual angle. When grating is printed on a surface, it can be defined also as the number of cycles per centimeter of surface (CPCM). Test distance is 57 cm and the vision is measured in CPD (cycles per degree).

Paddles printed with 0.25, 0.5, 1, 2, 4, 8 cycles per centimeter were presented individually along with the grey paddle at the child's eye level and the results were measured. Children who could not go beyond .25 and .5 were considered to have very poor visual response. The room was well illuminated and free from distractions. The same test was administered multiple times with short intervals with a few kids considering their emotional and health conditions. It was indeed the role of the professionals to observe the infant's eye movements when the paddles were presented.

The parents were oriented about the visual milestones and the importance of encouraging the children to use their vision to the extent possible.

Visual skill training focused on the presentation of various visual stimuli in all the visual quadrants to elicit the response from the child. The visual stimuli could be illuminated objects, non- illuminated brightly colored toys, slinkies, shiners, illuminated colourful vibrating toys, preferential pattern cards and multicoloured transparent beads etc. Visual skill training also involves visual cognition to perceive symbols, numbers & letters, interactive play and games.

The children were given visual skill training for the duration of 30 - 45 minutes once a week in the vision rehabilitation centre. Parents were also trained in these skills and advised to incorporate the same for 10 minutes a day at intervals with the real life situations and not to

over stimulate them. These children were called for a review once in two months and the parents were questioned about the regularity of providing training. Most of them provided training as suggested except for the period when the children were sick. After a year, the children were tested again for the Grating Acuity and the results were noted down. Researcher who did grating acuity assessment was masked from the previous assessment results to make sure that the collected data is true. This study was approved by Frontline Eye Hospital's Review Board and followed the principles of Helsinki Declaration. Informed consents were obtained from the parents of the children in the study and also from the parent in the picture to publish the photograph.

RESULTS

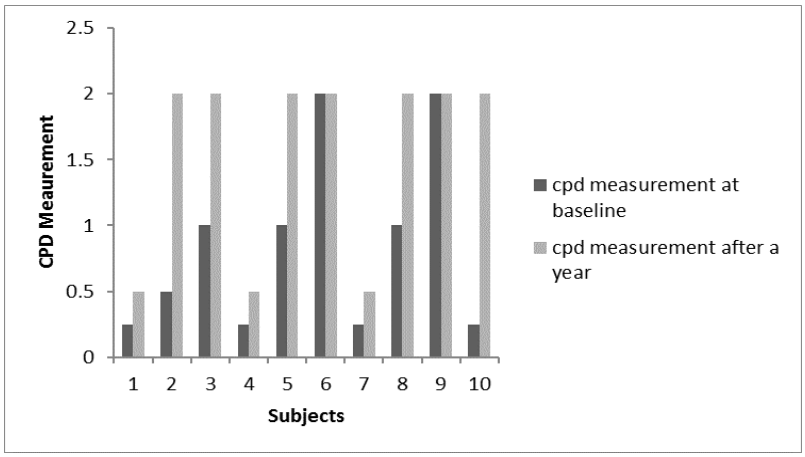
Fig 3 provides the details of the grating acuity assessment and other diagnosed conditions of all children.

Fig 3: Details of the children with grating acuity results

Number of children	Age	Sex	Grating acuity Assessment in CPD	Grating Acuity Assessment after a year	Other diagnosed conditions
1	5	M	0.25	0.5	Seizure disorder, Cerebral Palsy
2	3	F	0.5	2	Hydrocephaly
3	2	M	1	2	Hypoxic Ischemic encephalopathy, seizure disorder
4	3	M	0.25	0.5	Hypoxic Ischemic encephalopathy
5	3	M	1	2	Cerebral palsy
6	2	M	2	2	Seizure disorder
7	2	M	0.25	0.5	Seizure disorder
8	1	M	1	2	-
9	5	F	2	2	Diffuse cerebral atrophy, Cerebral Palsy
10	2	M	0.25	2	Cerebral Palsy

A paired t-test was performed for CPD measurement at the beginning and at the end of one year after training. It revealed a statistically significant improvement (< 0.05) in vision at the end of one year. Fig 4 shows the bar chart of CPD measurement of all subjects at the baseline and after one year.

Fig 4: CPD measurement at baseline and after a year



There was a positive correlation between the baseline CPD measurement and one year post training measurement.

DISCUSSION:

On a study in Oman, the children who did not respond for distant acuity tests using charts were screened using Lea's grating paddle. The test determined the visual perception of children by the preferential looking method. The acuity was recorded when the child could differentiate smallest strips from the plain paddle. Acuity was normal if the child labelled 2cpcm or more, less than 2cpcm was considered to be defective. Hiding Heidi picture of 100% contrast were shown for the infants who did not respond to Lea's grating paddle. The positive response towards the picture in test was considered for the presence of preferential looking (Rajiv, Saleh Al, and Ali Jaffer, 2010). Our study considered 0.25cpcm or more to consider the presence of vision and to advise further training for vision enhancement.

Grating acuity assessed by preferential looking was based on the assumption of infant preference to look at visible patterns over blank fields. Further to that assumption, preference for gratings compared to the blank fields would decline monotonically from 100% to 50% because of the increase in spatial frequency from above to below threshold gratings. The result was contradictory to the assumption that the preference falls below 50% and only rise in high spatial frequencies, which states the infant was preferentially fixating at the blank field (Held, Gwiazda, Brill, Mohindra, Wolfe, 1979).

The subjects in our study responded well for the preferential patterns than the blank field. Limitation of this study is that it did not have a control group as these children were mainly referred for early intervention services and could not be left untrained for a year. As the rehabilitation centre has the limited facility to cater to the needs of a large number of population with developmental delay, the sample size was very small. It is recommended to the tertiary vision rehabilitation centres to carry out research in various visual functions of children with developmental delay and additional disabilities with larger samples.
Information on grating / detection / visual acuity of children with developmental delay or multi-sensory impairment plays a crucial role in making decision regarding the medium and mode of learning and also in framing recommendations to special or regular schools so that the child can reach the next level comfortably.

CONCLUSION

Current study compared the results of the grating values after a period of one year with visual skill training. A marked improvement is felt with majority of the kids which reflected in the grating acuity results. The improvement could be the development itself provided with skill training. The improvement is nil or very minimal with a few kids. The reasons could be the health issues, seizure patterns & treatment, cognitive deficits, lack of required therapies, other disabilities etc. Periodic assessment of visual efficiency among children with development delay reveals the possibility of vision development with visual skill training.

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