Children with Cerebral Palsy were at a higher threat of having vision problems\(^{(52)}\), \(^{(56)}\). The aim of the study was to look at the nature of visual capacity among children with Cerebral Palsy. The comprehensive ocular examination in this study was completed in the respective rehabilitation centres i.e., schools for children with special needs where they get their routine rehabilitation therapy on a regular basis. This provided the examiner an essential benefit of getting full cooperation from the subjects during the assessment as it was conducted in a familiar place for them. Moreover, the teachers as well as the parents were instantaneously obtainable to be informed about the difficulties of the children and were offered appropriate management options.

Among 328 subjects, 190 were males and 138 were females in CP group. 169 were males and 159 were females in normal group. The gender is equally distributed in both CP and control group. The age range with a mean and standard deviation was \((78.15\pm54.08\text{months})\) in CP group and \((88.5\pm56.25\text{months})\) in normal group.

Visual acuity was measured using fixation pattern test, Lea Paddles and Lea symbols based upon the cognitive ability of the child and not based on the age. Lack of concentration, fatigue and non-motivation to the visual acuity tests throughout the testing period in some children may be the factors for reduced visual acuity. The perfect assessment of visual acuity in children with Cerebral
Palsy is not an easy task. Almost every child in this study, reliable methods of detection visual acuity like Lea paddles was used. Fixation pattern, the CSM technique, was used in the children who did not respond to detection acuity testing though was a qualitative visual acuity measurement. The visual acuity recorded based on the best effort offered by the child during the test. It may not be the best acuity of the child, it could be the best effort made by the child.

On comparing visual acuity assessed using Lea symbols and Lea paddles between CP group and the control group, there was significant difference statistically (P =0.0005). Also visual acuity assessed using fixation pattern tests showed significant difference statistically (P =0.001) on comparing both the groups. Snellen equivalent visual acuity was recorded for children who responded to Lea symbols, 57.69% of children with CP had visual acuity from 6/6 to 6/12 and 40.38% had visual acuity less than 6/18. Therefore, out of 328, 102 (31%) children with Cerebral Palsy had normal visual acuity; remaining 69% had reduced visual acuity. As the accurate measurement of visual acuity in children with Cerebral Palsy was a difficult task, the presenting visual acuity recorded for each child may not actually be their best corrected visual acuity; it could be the best effort the child had offered.

On extensive literature search, a spectrum of visual disorders was prevalent in children with Cerebral Palsy. The prevalence of ocular abnormalities in children with Cerebral Palsy was found to be higher than the general population of school children. The findings in our study also confirm the same with an incidence of 79.6% of children with Cerebral Palsy having more than one visual disorder.
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Hence, comprehensive ocular examination has to be included in the existing protocol for all the children diagnosed as Cerebral Palsy.

Peter Black (1992), reported visual field defects in 11% of Cerebral Palsy children and Nikos Kozeis et al. found that 80.95% were with normal visual field. Lea flicker wand was used to assess the visual fields in all the children in our study. 240(73.14%) had symmetric visual field and 88(26.86%) had asymmetric visual field the CP children. Out of 88 with asymmetric visual field defect, 78(88.6%) were Spastic CP. Out of 78 in Spastic group, 44(56.4%) were Hemiplegic, 22(28%) were Diplegic, 5(6.4%) were Monoplegic and 7 (8.9%) were quadriplegic. 26.86% of children with Cerebral Palsy in the present study had visual field defects. Asymmetric visual field was seen more in spastic quadriplegia (56.41%). This underlines the need for a comprehensive eye examination that includes examination of visual field for all children diagnosed as Cerebral Palsy.

Presence of manifest strabismus (tropia) was identified by performing Hirschberg’s test. Tropia was present in 106(32.3%) children with Cerebral Palsy. Among those 54(50.94%) of them had esotropia, 52(49.06%) had exotropia. This finding was similar to that of studies conducted in other parts of the world (India 35.7%, Japan 33.1%, Africa 50%). Among those 54(50.94%) of them had esotropia, 52(49.06%) had exotropia.

Various ranges for the incidence of nystagmus have been reported in CP (1.02% - 18%), and our study finding of 7.9% agrees with this range. 26(7.92%) children with Cerebral Palsy had nystagmus in our study; among them 25(96.15%)
were spastic and 1(3.8 %) was mixed CP. Incidence of nystagmus was more in spastic quadriplegics which was statistically significant. Out of 26 children with Cerebral Palsy had nystagmus, 4(15.4%) had normal vision and 22(84.6%) had reduced vision. In KatochSabita’s study Horizontal jerky nystagmus was found in 5.5% in children with Cerebral Palsy(57).

Previous studies show that ocular defects vary depending on the type of Cerebral Palsy. Spastic children were more likely to have ocular defects than athetoid and ataxic children because of more extensive diffuse involvement of brain. Even our study agrees with the same as more number of children with Spastic type of CP were found to have various ocular defects.

Refractive error was assessed using Cycloplegic refraction. There was no adverse reactions in our study on using 0.5% cyclopentolate and 1% tropicamide(58). Increased heart rate with greater concentration and duration of dilation with topical instillation of atropine and tropicamide was noted in some studies from the literature. Hence, cycloplegics were generally contraindicated in Down’s syndrome. However, from the literature, there was no documented evidence of adverse reactions to topical cyclopentolate recorded in children with Cerebral Palsy.

The research literature generally indicates that the most common type of visual issue in children with Cerebral Palsy was refractive error, (88.93%). However, Govinda et al. (n=70) found 35.7% of strabismus which was higher than the other ocular abnormalities. Few other studies from other parts of the world
found 28.5% to 54% had refractive errors in children with Cerebral Palsy. Many other studies from the literature stated more prevalence of hyperopia in children with Cerebral Palsy, our study did agree all the above findings observed in these studies.

Fantl and Perlstein report that myopia was more prevalent in Spastic Cerebral Palsy and hypermetropia was found to be more in Dyskinesia Cerebral Palsy. In our study, 6.40% of children with CP were myopes, 23.17% were hyperopes, 53.66% were astigmats and 16.77% were emmetropes.

Kozeis and Anogeianaki et al., found 40.9% of children with Cerebral Palsy in the study had astigmatism. Govinda and Lamba found 50% were astigmats in their study. We found the incidence of astigmatism (53.66%) to be considerably larger compared to the control group.

Among the children with Cerebral Palsy who had astigmatism, 26.70% were with-the-rule astigmatism, and 73.29% were against-the-rule astigmatism. Moreover, during the data collection, we found that only 29(11%) of the children with Cerebral Palsy used spectacles. This emphasized the need for appropriate visual aids for refractive problems in children with Cerebral Palsy and the importance of the optical intervention to be counselled well to the parents.

As expected, the highest spherical mean values were found in the youngest children. Under 48 months of age, similar levels of hyperopia was observed in both the groups though studies from previous literature showed consistently higher
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hyperopic error in the group of children with Cerebral Palsy than the levels shown by the children of the non-pathological control group.

The greater incidence of refractive error in the younger age group, infers that the emmetropization process may be affected. Some of the studies state between 48 and 60 months of age, children with spastic CP continued to show spherical mean values significantly higher than those observed in the non-pathological control group. Therefore, a delayed emmetropization process could happen in children with spastic CP than in non-pathological children. Whereas, in our study, children with CP between 48 and 60 months of age, had similar amount of hyperopia compared to control group. The amount of hyperopic error was found to lesser in more than 5yrs of age both in the CP group and control group and there was no statistically significant difference between both the groups. Whereas there was significant difference in the cylindrical refractive error between the both the groups with p<0.0005. More number of children with Spastic CP were found to have moderate degree of astigmatism when compared with the control group and it was predominantly against-the-rule astigmatism (ATR).

Our study matches with the prevalence of refractive error in Down’s syndrome. Our findings point to the need for further studies to document the development of refractive errors in children with CP.

Dynamic retinoscopy was performed with conventional correction for all the children with CP. Children who were using glasses wore their spectacle correction; the remaining children wore their Cycloplegic value on the trial frame.
before performing dynamic retinoscopy. Accommodative response was measured using Monocular estimation method (MEM) dynamic retinoscopy technique. The presence of motor and cognitive disabilities makes accurate measurement challenging. For each child, at least two measurements were taken in order to be assured of accurate, reliable measures. The procedure was assessed twice to reconfirm the values.

The mean and standard deviation of accommodative response of normal children was found to be (0.76± 0.26DS). The mean and standard deviation of accommodative response of CP children was found to be (0.367 ± 0.67 DS). Accommodative response was statistically significant with P=0.0005 while comparing both the groups.

Other research studies have found reduced accommodation in Cerebral Palsy. Susan J. Leat found that 42% of children with Cerebral Palsy had abnormal accommodative response for their age (59). In our study, out of 262, 211(80.53%) had lag of accommodation and 35 (13.35%) had lead of accommodation, 17 (8.05%) had lag of accommodation > 1.25 DS. Most of the children with Cerebral Palsy were spastic quadriplegics, 15(88.24%) had lag of accommodation. The common refractive error was found to be hyperopia (52.94%) in children who had lag of accommodation. Near visual acuity was affected for those children whose distance visual acuity was less than normal.

Identification of an unexpected number of children with Cerebral Palsy who had a lead of accommodation was the unique finding of the study. It was
found more in the children who had Spastic CP. The reason for lead of accommodation probably may be due to spasm of ciliary muscle or excessive stimulation of the III nerve in children with CP. There is no mention about lead of accommodation in children with Cerebral Palsy on extensive literature search. Hence the visual functions and refractive status of these children with lead accommodation were analyzed. Out of 35, 8 (22.86%) had normal visual acuity and 27 (77.14%) had reduced visual acuity. 23 (65.71%) were spastic type, 3(8.57%) were non-spastic and 9 (25.71%) were mixed type. 4 (11.43) were myopes, 8 (22.86%) were hyperopes, 22(62.85%) were astigmats and 1(2.80%) emmetrope. Out of 35, 17(48.5%) had strabismus, out of which, 7(4%) had esotropia and 10(28.57%) had exotropia.

Out of 262 children with CP, 17(6.48%) had Lag of accommodation >1.25DS and for 9 children glasses were prescribed. 210(92.51%) had Lag of accommodation (<+1.25DS) and for 125 children, glasses were prescribed. 35(13.35%) had Lead of accommodation and for 19 children glasses were prescribed. There was no change in the accommodative responses during follow-up, therefore, no change of glasses given in the study.

Total number of children with CP in 3rd phase after accommodative response assessment, excluding drop-outs were 262. Out of 262, 55(20.9%) were emmetropes. Glasses were prescribed only in the 3rd phase, for153(58.3%) children with Cerebral Palsy, glasses were given Therefore, out of 54, for 25(9.5%) glasses were not prescribed as the refractive error was found to be lesser than the age-matched refractive status of normal children in hospital based Indian
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population and the remaining 29(11%) children were already wearing glasses. Bifocals were not prescribed for children with CP because they are unable to consistently control head and eye posture to effectively look down through the add segment. Single vision glasses were prescribed and their usage was monitored with the help of parents. A mild amount of myopia would be beneficial for children with >1.25 lag of accommodation, as separate pair of glasses or bifocals for near need not be prescribed as child could be advised to wear only for distance. If the glasses are worn full time, the child will not be able to see at near and may reject the glasses. Hence only single vision glasses were prescribed for myopes with reduced accommodation.

On analysing presence of tropai in children with lead of accommodation, out of 35, 7 had Esotropia and 10 had exotropia, none had Myopia. Moreover, there was no significant difference between cycloplegic and non-cycloplegic retinoscopy values in these children. Hence pseudomyopia was not seen in our study. Hence, there was no necessity to give change of glass prescription after performing dynamic retinoscopy as per our hypothesis. Refractive correction in terms of refractive error and habitual working distance were considered. We also noted the compliance of spectacles during the follow-up, in which 24.40% of children with Cerebral Palsy enjoyed wearing spectacles, 48% were uncooperative and 27.60% of children with Cerebral Palsy broke their spectacles.

As our study showed a significant prevalence of refractive errors, to understand the development of refractive errors in Cerebral Palsy, additional studies should be conducted in this context. Poor acuity and high refractive errors
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further impair accurate accommodative responses and normal visual development. In addition, poor control of extraocular muscles, inaccurate fixation, and the high incidence of strabismus and nystagmus are all likely to be the contributing factors, suggesting a complex multi-factorial problem. In the future, a prospective data detailing visual functions from infancy may help define how and when visual development in Cerebral Palsy varies from that of the neurologically normal infant and young child.

The development of accurate accommodation in infancy was linked to several visual functions including recognition and detection acuity. It was also likely to be influenced by refractive status. Usually children with Cerebral Palsy do not undergo a comprehensive eye examination due to a difficulty in making an assessment because of their mental and physical disability or with the idea that nothing much could be done to help them cope with their existing poor condition, but a proper examination with patience and skill makes one detect various abnormalities and help the child in some way or the other in his overall development because they rely heavily on visual information for their education.