·Clinical Research·

Ocular disorders in children with spastic subtype of cerebral palsy

A. Taylan Ozturk, A. Tulin Berk, Aylin Yaman

Department of Ophthalmology, Dokuz Eylul University School of Medicine, Izmir, Turkey

Correspondence to: A. Taylan Ozturk. Department of Ophthalmology, Dokuz Eylü l Üniversitesi Hastanesi Göz Hastalıkları Anabilim Dalı, İnciraltı, 35340, Izmir, Turkey. ataylan6@yahoo.com

Received: 2012-05-05 Accepted: 2013-03-05

Abstract

• AIM: To document common ocular abnormalities in children with spastic subtype of cerebral palsy (CP) and to find out whether any correlation exists between their occurance and etiologic factors.

• METHODS: Totally 194 patients with the diagnosis of spastic type CP were enrolled in this retrospective study. Detailed ophthalmic examinations were performed. Demographic data and neuroradiological findings were documented. Kruskal-Wallis, Mann Whitney U, Pearson Chi-square tests and Student´s *t* tests were used in the statistical analysis.

• RESULTS: The mean age was 64.7±44.2 months on the first ophthalmic examination. Prevalences of diplegia (47.4%) and tetraplegia (36.1%) were found to be higher than the frequency of hemiplegia (16.5%) in our study population. Etiologic factor was asphyxia in 60.8% of the patients. Abnormal ocular findings were present in 78.9% of the patients. Statistically significant poor vision was detected in tetraplegia group among all the spastic ubtypes of CP (P=0.000). Anisometropia and significant refractive error were found in 14.4% and 70.1% of the patients, respectively. Thirty-six children (18.6%) had nystagmus and 107 children (55.2%) had strabismus. Lower gestational age and birth weight were statistically higher in patients with esotropia than exotropia (P=0.009 and P=0.024, respectively). Abnormal morphology of the optic disc was present in 152 eyes (39.2%). Severe periventricular leukomalacia (PVL) was found in 48 patients and statistically significant poor vision was detected in the presence of PVL (P=0.000).

• CONCLUSION: Spastic diplegic or tetraplegic CP patients with positive neuroradiological symptoms, younger gestational age and lower birth weight ought to have detailed ophthalmic examinations as early as possible to provide best visual rehabilitation.

• **KEYWORDS:** cerebral palsy; periventricular leukomalacia; strabismus; ocular disorders, computerized tomography, magnetic resonance imaging

DOI:10.3980/j.issn.2222-3959.2013.02.19

Ozturk AT, Berk AT, Yaman A. Ocular disorders in children with spastic subtype of cerebral palsy. *Int J Ophthalmol* 2013;6(2):204-210

INTRODUCTION

Cerebral palsy (CP) is a static encephalopathy that may occur due to the damage in immature brain tissue in the prenatal or natal period. Motor, tonus and posture impairment are common findings of CP whereas mental retardation, learning disabilities, epilepsy, autonomic dysfunction, orthopedic problems, impairment in vision and hearing may accompany in various degrees [1-3]. CP is one of the most prevalent childhood neuromuscular diseases, with a mean prevalence of 4.4 in every thousand live births in Turkey [3]. Ophthalmologic problems are reported with the range from 50% to 90% in cases with the diagnosis of CP. However ophthalmologic findings are frequently diagnosed in the patients with tetraplegic or diplegic type of disease, there are limited evidence in the literature regarding associations between ocular and visual anomalies and etiology of CP [4-9]. Herein, we aimed to find out the frequency of ophthalmologic problems seen in patients with spastic CP, as well as the correlation between etiological factors and ocular findings.

SUBJECTS AND METHODS

Subjects We retrospectively reviewed the charts of 202 patients with the diagnosis of CP seen in our clinic between January 2004 and January 2011. All cases were between 6 months and 18 years old. As all the study patients were minors, their parents gave written informed consent prior to participation in conformity with the Declaration of Helsinki. CP subtypes were classified as spastic (tetraplegic, diplegic, hemiplegic), dyskinetic (coreoatetoic, ballismic, dystonic, ataxic), hypotonic and mixed according to the Crothers and Paine classification [4]. One hundred and ninety four cases with spastic type of CP were enrolled in this study. Although in 101 patients initial ophthalmological examinations were performed in different health centers, they were also consulted with our tertiary referral clinic because of the lack of regular follow-ups as well as inadequate therapeutic

intervention programs (such as eye patching treatment, prescription of spectacles, or planning of any essential strabismus surgery, *etc*). The ophthalmological findings of our first clinical visit were recorded and statistically analysed in 194 paticipants.

Methods All patients underwent a full ophthalmologic examination including fundoscopy, orthoptic assessment, cycloplegic refraction, assessment of visual acuity and binocular single vision, where cooperation was adequate. In 56.2% of the study population, best-corrected visual acuity (BCVA) could be measured using Snellen chart and Teller acuity cards whereas CSM (central, steady, maintained) were taken into account according to the bilateral fixation pattern in patients whose visual acuity could not be measured. The corrected visual acuity of the best eye was noted and used in statistical analysis as BCVA score of a participant. BCVA values measured using Snellen chart and Teller acuity cards cards (corresponding visual equivalents were initially measured according to the manufacturer using the conversion scale placed on each cards) were converted into logMAR unit for statistical analysis. For the purpose of this study, poor vision was defined as the visual acuity poorer than logMAR 1.0 or inadequate CSM while normal vision was defined as the visual acuity better than logMAR 1.0 as well as positive CSM. Orthoptic examination was performed with prism cover test or Hirschberg and Krimsky tests depending on the cooperation level of the patient. Restriction of ocular motility as well as the presence of nystagmus and its type were noted. Cycloplegia was accomplished with one drop of 1% cyclopentolate and 1% tropicamide, repeated in five to ten minutes, with retinoscopy performed after 45 minutes. To find out the refractive errors, retinoscopy was performed in all patients and confirmations were provided via autorefractometry (Retinomax; Right Manufacturing, Virginia Beach, VA) if possible. The cases to whom we had prescribed new spectacles were noted. Spherical equivalents, found by adding the half of cylindrical values to spherical values, were used in comparisons. Cases were assessed as emmetropic if between 0.75 diopters of myopic and hypermetropic equivalents, hyperopic if between +1.0 and +4.75 diopters, highly hyperopic if +5.0 diopters and above, myopic if between -1.0 and -4.0 diopters, and highly myopic if -4.25 diopters and above. Hyperopia, high hyperopia, myopia and high myopia were defined as significant refractive error. Greater than 1.0 diopter difference between each eye was considered significant anisometropia. Prescription of spectacles in patients with significant refractive error was determined by age, highest spherical or cylindrical refractive error of either right or left eye, and distance phoria. Prescribing spectacles was also considered in cases with hypoaccommodation, heterotropia, significant nystagmus, or anisometropia. As hypoaccommodation is commonly seen in patients with CP, dynamic retinoscopy was performed in order to find out accommodative insufficiency where the cooperation of the patient was adequate. Observation of possible decrease in the angle of strabismus in patients whose hyperopic refractive error was accurately corrected, helped maintaining an opinion on accommodation as well. Dilated fundoscopic examinations were performed with indirect ophthalmoscopy. All cases were screened for retrochiasmal involvement and the presence of periventricular leukomalacia (PVL) *via* cranial radiological examinations with computerized tomography and/or magnetic resonance imaging. Neuroradiological examinations aimed to investigate mainly the white matter adjacent to the lateral ventricles, and midline corpus callosum as well as the status of lateral ventricles. For the purpose of the study, diffuse PVL accompanying hydrocephalus with marked loss of white matter volume and corpus callosum agenesis was defined as severe involvement and the data of these cases were used in statistical analysis.

Table 1 Demographics [*n*(%)]

Age (months)	64.7±44.2 (6-216)
Gender	
Female	82 (42.3)
Male	112 (57.7)
Gestational age (weeks)	
≤32	73 (37.6)
33-37	32 (16.5)
≥38	89 (45.9)
Gestational weight (g)	
≤1250	31 (16.0)
1251-2499	67 (34.5)
≥2500	96 (49.5)
Clinical subtype of CP	
Spastic tetraplegia	70 (36.1)
Spastic diplegia	92 (47.4)
Spastic hemiplegia	32 (16.5)
Neuroradiological assessment	
Severe PVL (+)	48 (24.7)
Severe PVL (-)	146 (75.3)

The gestational age, birth weight, clinical subtype of spastic CP, etiology of CP, presence of PVL, presence of prior ophthalmological examination, presence of physical therapy and rehabilitation support, as well as conductive education status were recorded for all cases.

Statistical Analysis The data were stored on a computerized database and analyzed using SPSS 15.0 for Windows (Statistical Package for Scientific Studies for Windows, SPSS Inc., Chicago, IL, USA). Kruskal-Wallis, Mann Whitney U, Pearson Chi-square tests and Student's *t* tests were used in the statistical analysis and a *P* value of below 0.05 was considered as significant.

RESULTS

The charts of 194 patients with the diagnosis of spastic type CP were reviewed in the study. There were 82 girls (42.3%) and 112 boys (57.7%). Mean age of patients at the first ophthalmologic examination in our clinic was 64.7 ±44.2 months ranging from 6 months to 18 years. Distribution of both gestational age and birth weight of study participants were shown in Table 1.

Table 2 Visual acuity and refractive errors [*n*(%)]

	Spastic tetraplegia (*n*=70)	Spastic diplegia (*n*=92)	Spastic hemiplegia (*n*=32)
Visual acuity			
Poor vision	33 (47.1)	15 (16.3)	6 (18.8)
Cases (VA evaluated by SC/TAC)	23	63	23
Mean logMAR value	0.78±0.33	0.43±0.38	0.51±0.43
Refractive errors			
Emmetropia	33 (23.6)	48 (26.1)	19 (29.7)
Hyperopia	45 (32.1)	95 (51.6)	32 (50.0)
High hyperopia	13 (9.3)	7 (3.8)	0 (0)
Myopia	30 (21.4)	26 (14.1)	6 (9.4)
High myopia	19 (13.6)	8 (4.3)	7 (10.9)
Gestational age (weeks)			
≤32	24 (34.3)	42 (45.7)	7 (21.9)
33-37	8 (11.4)	18 (19.6)	6 (18.8)
≥38	38 (54.3)	32 (34.8)	19 (59.4)
Gestational weight (g)			
≤1250	13 (18.6)	15 (16.3)	3 (9.4)
1251-2499	15 (21.4)	40 (43.5)	12 (37.5)
≥2500	42 (60.0)	37 (40.2)	17 (53.1)

VA: Visual acuity ; SC: Snellen chart; TAC: Teller acuity cards.

Etiologic factors Etiologic factors were found to be asphyxia in 118 patients (60.8%), prematurity in 105 patients (54.1%), early membrane rupture in 5 patients (2.6%), intrauterine infection in 4 patients (2.1%), imminent abortus in 3 patients (1.5%), kernicterus in 2 patients (1.0%) and febrile convulsion in 2 patient (1.0%); the remaining 9 cases (4.6%) had cortical dysplasia of varying degrees. A single etiologic factor was evident in 144 of the study population (74.2%), however 2 or more etiologic factors that were thought to be related with the development of CP were present in 50 patients (25.8%).

Clinical subtype of disease was diagnosed as spastic tetraplegic in 70 patients (36.1%), spastic diplegic in 92 patients (47.4%), and spastic hemiplegic in 32 patients (16.5%) according to the Crothers and Paine classification [4]. No significant difference was found regarding the birth weight between the clinical subgroups of spastic CP (P= 0.123) but cases with the diagnosis of spastic diplegia were more likely to have lower gestational age (P=0.038) which could be seen in Table 2.

Magnetic resonance imagining was performed in 94.3% of the cases while the rest of the study population had neuroradiologically scanned *via* computerized tomography. Intracranial pathologies including periventricular leukomalacia (PVL) were present in 139 of the cases (71.6%), and 48 cases (24.7%) were found to have severe PVL defined for the purpose of this study. Table 3 represented the increased frequency of severe PVL existence in the spastic CP cases with a gestational age of ≤32 weeks, and a birth weight of ≤1250 grams (P=0.001 and P=0.000 respectively).

Rehabilitation status Although conductive education was received in 107 patients (55.2%) and 154 cases (79.4%) were being followed by physical therapy and rehabilitation specialists at referral, 93 patients (47.9%) had no prior ophthalmological examination. None of the study patients had a previous regular ophthalmological follow-up for strabismus, amblyopia, or refraction changes; and any previous ocular surgery was also not performed on study eyes. As a result of our examinations, 78.9% of the study population was found to have abnormal ocular findings.

Ocular findings of the study population Visual acuity could be assessed with the Snellen chart in 61 cases (31.4%), and with the Teller acuity cards in 48 cases (24.7%), whereas optokinetic nystagmus or CSM were taken into account according to the bilateral fixation pattern in the remaining 85 cases (43.8%). The mean best-corrected visual acuity of cases that could be measured using Snellen chart or Teller acuity cards was found as logMAR 0.52 ±0.40, also poor vision defined for the purpose of this study was found in 27.8% of 194 patients. Patients with the diagnosis of tetraplegic CP had statistically significantly lower vision compared to the remaining patients with spastic CP subtypes (P=0.000). Results were summarized in Table 2. Poor vision was measured in 58.3% of the 48 cases with severe PVL (Table 3) and this was statistically significant compared with the rate of poor vision measured in spastic CP patients without severe involvement of PVL (P=0.000).

Refractive errors that need presciption in at least one eye were found in 136 of 194 patients (70.1%). Of the total 388 study eyes, 100 (25.8%) were emmetropic, whereas 172 eyes (44.3%) were hyperopic, 20 eyes (5.2%) were highly hyperopic, 62 eyes (16.0%) were myopic, and 34 eyes (8.8%)

Table 3 Evaluation of the cases with severe PVL [n(%), $\bar{x} \pm s$]

	Cases with severe PVL (n=48)	Cases without severe PVL (n=146)	P
Vision			0.000
Poor vision	28 (58.3)	26 (17.8)	
Normal vision	20 (41.7)	120 (82.2)	
Mean refractive error	3.84±2.93 Diopters	1.79±1.41 Diopters	0.000
Clinical subtype of CP			
Spastic tetraplegia	20 (41.7)	50 (34.2)	0.353
Spastic diplegia	22 (45.8)	70 (47.9)	0.799
Spastic hemiplegia	6 (12.5)	26 (17.8)	0.390
Orthoptic assessment			
Orthophoria	7 (14.6)	80 (54.8)	0.000
Esotropia	27 (56.3)	[1]46 (31.5)	0.002
Exotropia	[2]13 (27.1)	18 (12.3)	0.016
Izolated vertical deviation	1 (2.1)	2 (1.4)	0.728
Nystagmus assessment			0.009
Nystagmus (+)	15 (31.2)	21 (14.4)	
Nystagmus (-)	33 (68.8)	125 (85.6)	
Gestational age (weeks)			
≤32	28 (58.3)	45 (30.8)	0.001
33-37	11 (22.9)	21 (14.4)	0.370
≥38	9 (18.8)	80 (54.8)	0.000
Gestational weight (g)			
≤1250	17 (35.4)	14 (9.6)	0.000
1251-2499	18 (37.5)	49 (33.6)	0.397
≥2500	13 (27.1)	83 (56.8)	0.000

[1]Case with mix strabismus (esotropia+vertical strabismus) was included; [2]Case with mix strabismus (exotropia+vertical strabismus) was included.

were highly myopic. More than one diopter of astigmatism was present in 101 eyes (26.0%). However significantly reduced frequency of hyperopia was found in patients with the diagnosis of tetraplegic CP (P=0.001); high hyperopia, myopia, and high myopia were seen more frequently in this subgroup (P=0.006, P=0.041, and P=0.012, respectively) that was shown in Table 2. Anisometropia was found in 28 patients (14.4%). After our ophthalmic examinations, 48 patients (24.7%) started to use spectacles. Mean refractive error was greater in cases with PVL when compared with those without PVL (P=0.000). Besides, heterotropia and nystagmus were also found more frequently in cases with PVL (P=0.000 and P=0.009, respectively) that were shown in Table 3.

Strabismus was found in 107 of 194 cases (55.2%) enrolled in the study. Esotropia was found to be approximately 2.5 times more than exotropia. Of the 73 patients with esotropia, 31 (42.5%) developed refractive accommodative esotropia. No statistically significant difference was found between the clinical subtype of the disease and the development of esotropia, however refractive accommodative esotropia was statistically significantly frequent in CP cases with spastic diplegia (P=0.016). Of the 73 patients with esotropia, 11 cases (15.1%) had variable angle strabismus that was also seen in 6 of 31 patients with exotropia (19.4%). When study participants with variable angle strabismus were excluded, mean angle of strabismus was found as 29.4 ±12.6 prism diopters (6-60 PD) in patients with eso-deviation, whereas it was found as 26.5±9.0 prism diopters (8-55 PD) in patients with exo-deviation. Vertical deviation was only seen in 5 cases and 3 of them (60%) had the diagnosis of spastic tetraplegia. Only two patients among the whole study population (1.0%) had mixed type deviation; one of these patients had concurrent eso- and the other had exo-deviation. Both lower gestational age and lower birth weight were found to be risk factors for the development of strabismus (P=0.001 and P=0.003, respectively). The relationship between the presence of strabismus and severe PVL was statistically significant (P=0.000). In terms of the anamnesis of the study population, lower gestational age and birth weight were to be risk factors for the development of esotropia compaired to exotropia (P=0.009 and P=0.024, respectively). Results were summarized in Table 4. After our ophthalmic examinations, strabismus surgery was scheduled in 31 cases (16.0%), eye patching treatment was recommended in 63 patients (32.5%), and new spectacles was prescripted after a cycloplegic examination in 63 patients (32.5%) whose control visits were planned within 3 months in order to retest for BCVA and refraction.

Nystagmus was found in 36 (18.6%) of cases, most

Table 4 Evaluation of strabismus subtypes [*n*(%)]

	Orthophoria	Horizontal strabismus		Isolated vertical deviation
		Esotropia	Exotropia	
Clinical subtype of CP				
Spastic tetraplegia (*n*=70)	28(40.0)	[1]27(38.6)	[2]14(20.0)	1(1.4)
Spastic diplegia (*n*=92)	40(43.5)	35(38.0)	15(16.3)	2(2.2)
Spastic hemiplegia (*n*=32)	19(59.4)	11(34.4)	2(6.3)	0(0)
Neuroradiological study				
Severe PVL (+) (*n*=48)	7(14.6)	27(56.3)	[2]13(27.1)	1(2.1)
Severe PVL (-) (*n*=146)	80(54.8)	[1]46(31.5)	18(12.3)	2(1.4)
Gestational age (weeks)				
≤32 (*n*=73)	21(28.8)	[1]40(54.8)	11(15.1)	1(1.4)
33-37 (*n*=32)	14(43.8)	13(40.6)	4(12.5)	1(3.1)
≥38 (*n*=89)	52(58.4)	20(22.5)	[2]16(18.0)	1(1.1)
Gestational weight (g)				
≤1250 (*n*=31)	6(19.4)	19(61.3)	6(19.4)	0(0)
1251-2499 (*n*=67)	29(43.3)	[1]29(43.3)	7(10.4)	2(3.0)
≥2500 (*n*=96)	52(54.2)	25(26.0)	[2]18(18.8%)	1(1.0)

[1]Case with mix strabismus (esotropia+vertical strabismus) was included; [2]Case with mix strabismus (exotropia+vertical strabismus) was included.

Table 5 Evaluation of nystagmus [*n*(%), $\bar{x} \pm s$]

	Nystagmus (+) (*n*=36)	Nystagmus(-) (*n*=158)	*P*
Vision			0.000
Poor vision	25 (69.4)	29 (18.4)	
Normal vision	11 (30.6)	129 (81.6)	
Clinical subtype of CP			0.002
Spastic tetraplegia	22 (61.1)	48 (30.4)	
Spastic diplegia	10 (27.8)	82 (51.9)	
Spastic hemiplegia	4 (11.1)	28 (17.7)	
Mean refractive error	3.84±2.93 Diopters	1.79±1.41 Diopters	0.000

frequently of the pendular type. Poor vision defined for the purpose of this study and higher refractive errors were found to be statistically significant in the presence of nystagmus (P= 0.000 and P=0.000, respectively) that were shown in Table 5.

Abnormal disc morphology was observed *via* indirect ophthalmoscopy in 152 eyes (39.2%). Most frequent disc pathologies were paleness (18.3%), cupping (10.3%), hypoplasia (4.9%), and optic atrophy (5.7%) in our study population.

DISCUSSION

Patients with the diagnosis of cerebral palsy require treatment and support with a multidisciplinary approach. After diagnosis by pediatric neurologists, masterminding of close follow-up by especially physical therapy and rehabilitation specialists is crucial. It is also very important for these children to receive conductive education at an early stage with the support of psychiatrists and psychologists. Conductive education is a professional programme in which educational and rehabilitational goals are integrated. It provides to assist children with motor dysfunction in order to attain maximum orthofunction as possible by repetitive learning techniques, also conductive education emphasizes communication and places the individuals in group settings to stimulate their senses and body on multiple levels, which maximizes active learning and functionality in order to gain them in society.

Etiological studies in order to find out the major predisposing conditions for CP development may have a guiding role in lowering the prevalence of the disease. Asphyxia without respect to the gestational age was found to be the leading etiologic factor in 60.8% of our study population. The rate of asphyxia as an etiologic factor for CP was published between 26% and 71% in the previous studies conducted in Turkey[8,9]. From the history of our patients, prematurity was shown as the second most common etiologic factor with a rate of 54.1% and statistically significant correlation between prematurity and the development of spastic type CP was found which is in accordance with the previous studies[8-10]. In developed countries, spastic diplegic subtype of CP was found to be more frequently in parallel with the increase in the survival rates of premature babies, whereas in developing countries spastic tetraplegic type CP was seen more frequently[3,11]. Diplegia was found as the dominant type of CP in Turkish population and 71.6% of those cases had a history of preterm birth [3]. Spastic diplegia was also the most common subtype of disease in our prematurely born CP cases

with a rate of 52.3%. Low gestational age and weights in cases even without CP may be associated with deteriorated visual functions, as myopia related with preterm birth, delayed visual maturation, and especially retinopathy of prematurity (ROP) are some of the well known causes of poor vision among such cases. However, no sign of cicatricial ROP in any stage was found on fundoscopic evaluation of the study population.

Ophthalmological problems are reported with the range from 50% to 90% in cases with the diagnosis of CP [4-9]. Relation between frequency and severity of visual sensory problems and motor-mental deficits in children with CP also was reported [6,12,13]. Thus, cerebral palsied children must be referred to ophthalmologists at an early stage for visual rehabilitation which is one of the important parameters in increasing the physical and intellectual capacity of them. In the present study, ocular abnormalities were found in 78.9% of cases and this rate was found to be consistent with literature. Ophthalmologic problems were reported to be frequent in the spastic diplegic subtype of disease which is indicated as the most common CP type in literature[6,7,13-15]. On the other hand, ocular problems were rarely reported in the cases with dyskinetic type of CP[14].

Previous studies demonstrated CP related ophthalmologic problems, including strabismus and refractive errors with the rates between 28% and 86%. The frequency of strabismus may be affected especially from the severity of visual motor system involvement [4-7,12-17]. In our study group, presence of strabismus was 55.2%, and the ratio of esotropia to exotropia was found as 2.5:1. These results are consistent with the literature rates varied between 25% and 69% [6,9,15-20]. Strabismus was found most frequently in tetraplegic and diplegic subtypes of spastic CP which is in accordance with the previous studies [12,15]. In premature cases where the incidence of spastic diplegic type CP increases, strabismus and refractive errors were reported to occur much more commonly. Clinical trials emphasized the relation between strabismus and prematurity with the frequency of 5%-24% [5,18,20]. Lower gestational age and birth weight were found as an etiologic factor for increasing risk of strabismus and especially esotropia which was also mentioned in literature[12,17,20]. Of the 73 patients with esotropia, 31 (42.5%) developed refractive accommodative esotropia which was statistically significantly frequent in CP cases with spastic diplegia, in the present study. Treatment procedure as correcting the refractive errors followed by occlusion of the fellow eye was applied in such cases, but the efficiency of occlusion was not beneficial as expected because of the poor compliance especially in patients with intellectual impairment. Many factors such as initial visual acuity, the age of the patient at initial therapy, the duration and method of the occlusion therapy as well as the level of compliance were found to be related with the response of the eye patching treatment in many published studies[21,22].

We found significant refractive errors which were primarily hyperopic in 70.1% of the study eyes. Kozeis *et al* [13] reported significant refractive errors in 62.9% of their study eyes. The frequency of refractive errors in cerebral palsied Turkish children was stated as 77.9% by Cumurcu *et al* [15]. Lower vision was found frequently among patients with spastic tetraplegic CP that was also found to be consistent with literature [12,23,24]. The development of accurate accommodation in infancy is especially associated with visual acuity and convergence ability which are also related with refractive status [25]. Research demonstrates associations between severity of physical and intellectual impairments in cerebral palsy and accommodative dysfunction [26]. The reduction of accommodation in such patients due to the high prevelence of significant refractive errors was also found to be linked with the high frequency of squint [27]. However infant hyperopia was frequent in our study group, accommodative deficiency related with eso-deviation was also present in 32.0% of the hyperopic cases.

Intracranial pathology is located especially on the basal ganglia in athetoid children, and on the cerebellum in ataxic children; whereas more extensive intracranial involvements such as PVL and cortical atrophy may be faced in spastic cases. Therefore, patients with spastic subtype of CP are more prone to have deteriorated visual functions than athetoid and ataxic cases [2,6]. In case of any suspicious poor visual function, neuroradiological investigation is mandatory in children with CP, as especially spastic diplegia is generally accompanied with mild to severe PVL. Neuroradiological evaluation may provide not only specifying the nature of visual deterioration, but also guiding physician in establishing earlier and more successful rehabilitation programme for cerebral palsied child [16,17]. PVL is much more commonly diagnosed in prematurely born infants. Thus, published studies stressed the importance of neuroradiological evaluation in the presence of CP related with prematurity. Increased risks of strabismus and refractive errors related with PVL which was one of the causes of cortical loss of vision especially in case of the visual pathway involvement were reported [17,28,29]. Presence of poor vision and strabismus was statistically significant in our study patients with severe involvement of PVL. Delayed visual maturation, decreased visual acuity, visual field defects as well as visual perceptual-cognitive problems can be seen in cases with PVL. Optic disc abnormalities, strabismus and nystagmus may commonly accompany to the visual impairment. Clinical spectrum of children with PVL at referral to the ophthalmologist may vary from mild visual impairment, early onset squint with normal motor-mental status to severe visual dysfunction with CP [28,29]. Early neuroradiological evaluation for screening the presence and localization of PVL in patients with CP shall both give information about visual prognosis,

and guide the clinician to notice the parents about ophthalmic problems that may develop in time.

The frequency of optic atrophy was found as 5.7% in our study while this rate might go up to 20% in published studies. However paleness of disc, which could be seen before the development of total optic atrophy, was found as 18.3%. Optic nerve hypoplasia, that may be described as low axon numbers due to the shrinkage of the optic disc area, is a developmental defect of the disc. Optic nerve hypoplasia was seen in 4.9% of the study group which is in accordance with the rates (2%-13%) reported in literature[6,9,12,13,15,16,30].

In developing countries such as Turkey, not only retinopathy of prematurity, but also CP should be considered in prematurely born children. In cases with CP, early detection of both motor-mental and visual impairment is very important for improvement in visual prognosis. However all of the patients were being followed by pediatric neurologists and/or physical therapy and rehabilitation specialists, frequency of the cases who had the first visit to ophthalmologist in their life was 47.9% in the present study. For improving the psychosocial prognosis of CP, it is mandatory to remember ophthalmologic consultations of such patients and make their therapy programs with a multidisciplinary approach.

In conclusion, decrease in visual acuity which is commonly seen in spastic type CP, affects the physical and intellectual capacity of patients. Visual function is an important parameter that directly affects learning performance through conductive education in the process of the gaining these cases in society. Therefore, cases with CP ought to be referred to ophthalmologists at an early stage for a detailed ophthalmologic examination. Especially spastic diplegic and tetraplegic CP cases with positive neuroradiologic findings as well as lower gestational age and birth weight must be assessed by an ophthalmologist as early as possible.

REFERENCES

1 Morris C. Definition and classification of cerebral palsy: a historical perspective. *Dev Med Child Neurol Suppl* 2007;109:3-7

2 Dutton GN, McKillop ECA, Saidkasimova S. Visual problems as a result of brain damage in children. *Br J Ophthalmol* 2006;90(8):932-933

3 Serdaroglu A, Cansu A, Ozkan S, Tezcan S. Prevalence of cerebral palsy in Turkish children between the ages of 2 and 16 years. *Dev Med Child Neurol* 2006;48(6): 413-416

4 Crothers B, Paine RS. The natural history of cerebral palsy. Cambridge: Harvard University Press, 1959

5 Pennefather PM, Tin W. Ocular abnormalities associated with cerebral palsy after preterm birth. *Eye(Lond)* 2000;14(Pt 1):78-81

6 Black P. Visual disorders associated with cerebral palsy. *Br J Ophthalmol* 1982;66(1):46-52

7 Grether JK, Cumminis SK, Nelson KB. The California cerebral palsy project. *Pediatr Perinat Epidemiol* 1992;6(3):339-351

8 Güven A, Deda G, Karagül U, Uysal S. Cerebral palsy. *Ankara Üniversitesi Tip Fak ü ltesi Mecmuasi* 1999;52:13-17

9 Duman Ö, Ïmad FM, Kızılay F, Yücel Ï, Balkan S, Haspolat S. Evaluation of visual problems in patients with cerebral palsy according to functional capacity. *Çocuk Sagluğ ve Hastalikları Dergisi* 2005;48:130-135

10 McDonald AD. Cerebral palsy in children of very low birth weight. *Arch Dis Child* 1963;38(202):579-588

11 Ipek B, Ecevit C, Ipek I, Kocabas O, Kavakli T, Ozturk A. The evaluation of 371 cases with Cerebral Palsy between January 1984 and December 2004. *Neuro Sci* 2007;24(4):270-279

12 Ghasia F, Brunstrom J, Gordon M, Tychsen L. Frequency and severity of visual sensory and motor deficits in children with cerebral palsy: Gross motor function classification scale. *Invest Ophthalmol Vis Sci* 2008;49(2): 572-580

13 Kozeis N, Anogeianaki A, Mitova DT, Anogianakis G, Mitov T, Klisarova A. Visual function and visual perception in cerebral palsied children. *Ophthalmic Physiol Opt* 2007;27(1):44-53

14 Buckley E, Seaber JH. Dyskinetic strabismus as a sign of cerebral palsy. *Am J Ophthalmol* 1981;91(15):652-657

15 Cumurcu T, Cumurcu HB, Erkorkmaz Ü, Yardım H. Ocular findings in children with cerebral palsy. *Firat Tip Dergisi* 2007;12:48-52

16 Katoch S, Devi A, Kulkarni P. Ocular defects in cerebral palsy. *Indian J Ophthalmol* 2007;55:154-156

17 Jethani J. Ocular defects in cerebral palsy. *Indian J Ophthalmol* 2007; 55:397

18 Dowdeswell HJ, Slater AM, Broomhall J, Tripp J. Visual deficits in children born at less than 32 weeks' gestation with or without major ocular pathology and cerebral damage. *Br J Ophthalmol* 1995;79(5):447-452

19 Contane M, Peris E, Sanchez E. Ocular dysfunction associated with mental handicap. *Ophthalmic Physiol Opt* 1995;15(5):489-492

20 O'Keefe M, Kafil-Hussain N, Flitcroft I, Lanigan B. Ocular significance of intraventricular hemorrhage in premature infants. *Br J Ophthalmol* 2001;85(3):357-359

21 Hussein MA, Coats DK, Muthialu A, Cohen E, Paysse EA. Risk factors for treatment failure of anisometropic amblyopia. *J AAPOS* 2004;8 (5): 429-434

22 Park KH, Hwang JM, Ahn JK. Efficacy of amblyopia therapy initiated after 9 years of age. *Eye(Lond)* 2004;18(6):571-574

23 Da Cunha Matta AP, Nunes G, Rossi L, Lawisch V, Dellatolas G, Braga L. Outpatient evaluation of vision and ocular motricity in 123 children with cerebral palsy. *Dev Neurorehabil* 2008;11(2):159-165

24 Jan JE, Lyons CJ, Heaven RK, Matsuba C. Visual impairment due to a dyskinetic eye movement disorder in children with dyskinetic cerebral palsy. *Dev Med Child Neurol* 2001;43(2):108-112

25 Currie DC, Manny RE. The development of accommodation. *Vision Res* 1997;37(11):1525-1533

26 McClelland JF, Parkes J, Hill N, Jackson AJ, Saunders KJ. Accommodative dysfunction in children with Cerebral Palsy: A population-based study. *Invest Ophthalmol Vis Sci* 2006;47(5):1824-1830

27 Ross LM, Heron G, Mackie R, McWilliam R, Dutton GN. Reduced accommodative function in dyskinetic cerebral palsy: a novel management strategy. *Dev Med Child Neurol* 2000;42(10):701-703

28 Fazzi E, Bova S, Giovenzana A, Signorini S, Uggetti C, Bianchi P. Cognitive visual dysfunctions in preterm children with periventricular leukomalacia. *Dev Med Child Neurol* 2009;51(12):974-981

29 Dutton GN, Saaed A, Fahad B, Fraser R, McDaid G, McDade J, Mackintosh A, Rane T, Spowart K. Association of binocular lower visual field impairment, impaired simultaneous perception, disordered visually guided motion and inaccurate saccades in children with cerebral visual dysfunction-a retrospective observational study. *Eye (Lond)* 2004;18 (1): 27-34

30 Jacobson L, Hellstrom A, Flodmark O. Largecups in normal sized optic discs-a variant of optic nerve hypoplasia in children with periventricular leukomalacia. *Arch Ophthalmol* 1997;115(10):1263-1269