# RETINOSCOPY AND VISUAL EVOKED POTENTIAL BASED EVALUATION OF THE EXACTNESS OF HYPEROPIA CORRECTION IN CHILDREN WITH DEVELOPMENTAL DIFFICULTIES

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SUMMARY – The aim of this study was to evaluate the possibility of evaluation of optimal hyperopic correction based on visual evoked potential (VEP) examination results in children that do not cooperate. There are relatively few studies that evaluated the correlation between visual acuity and especially in young hyperopes. We examined 80 children (160 eyes) with hyperopia, divided into two groups: children that were cooperative during examination and children that could not cooperate with the examiner. Upon determination of the eye refractive state by other objective methods, the prescribed refraction was checked by following the change in VEP P100 wave amplitude and prescribed the correction for which these values were highest. The first VEP curve was recorded without any correction, then more VEP curves were recorded after increasing correction between +1.0 and +6.0 D, in the range found by retinoscopy, with 1 D step. The correction values that caused VEP curves with highest amplitude and shortest P100 wave latency were recorded. In conclusion, the VEP curve parameters were confirmed to depend on the refractive state of the eye.

Key words: *Visual acuity; Evoked potentials, visual; Child; Visual disorders – physiopathology; Vision, ocular – physiology*

## Introduction

The evaluation of visual correction in children that do not cooperate (mentally retarded) is a big challenge. Ophthalmoscopy serves only for rough orientation, and it consists of turning Rekoss's disk until a neat funduscopic view is obtained[1,2]. Automatic refractometer cannot be used in children with mental retardation[3]. Visual acuity depends on the refractive state of the eye. Hyperopes are corrected with plus correction, convex lenses. Young hyperopes, especially children, use the accommodation which compensates for part of their refractive anomaly. This is the reason why sometimes it is difficult to evaluate the right correction in hyperopic children, since they do not accept full correction found by cycloplegic retinoscopy, where the possibility of accommodation is excluded. There are relatively few studies that evaluated the correlation between visual acuity and visual evoked potentials, especially in young hyperopes[4,5]. The refraction in children that cannot collaborate during the examination was evaluated by retinoscopy and visual evoked potentials (VEP)[6].

We examined 80 children (160 eyes) with hyperopia, divided into two groups. One group included children that were cooperative during the examination, and the other group included children that could not cooperate with the examiner. We selected children with hyperopia because hyperopia is the most common refractive anomaly[7]. Six percent of 1-year-old children have confirmed refractive anomaly, mostly hyperopia over +3.50 sphere[8]. Refractive anomalies were found in one-third of mentally retarded persons[9,10]. The aim

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of this study was to evaluate the possibility of evaluation of optimal hyperopic correction based on VEP examination results in uncooperative children.

## Subjects and Methods

Retinoscopy in cycloplegia and pattern VEP examination was done in 80 children aged 4-6 years. We used 73.2 min special frequency, 1 rps temporal frequency, and 99% contrast pattern with acquisition time of 300.0 ms. Cooperative children were examined using trial lenses.

First VEP curve was recorded without any correction, then more VEP curves were recorded after increasing correction between +1.0 and +6.0 D, in the range found by retinoscopy, with 1 D step. For every correction change, the examination was repeated three times in order to eliminate the possible errors caused by poor cooperation. We recorded the correction values that caused VEP curves with highest amplitude and shortest P100 wave latency. The curve with the highest amplitude and shortest latency was marked as the best one.

Statistical analysis was done using computer program SPSS, version 12.0. Chi-square test was used to test the correlation of nominal variables. F-test was used to test the difference between the mean values of numerical variables, or with analysis of variance if there was one changing factor (factor means a group: cooperation *vs.* non-cooperation). Pearson's coefficient of linear correlation was used to test the correlation between numerical variables. A $P$ value <0.05 was considered statistically significant.

## Results

Retinoscopy was done with cycloplegia in both groups of children (Fig. 1). Retinoscopy values ranged from +2.0 to +6.0 sphere diopters in both groups. The mean retinoscopy value in the uncooperative group was +4.26 D ±1.06, and in cooperative group +4.60± 0.87. Higher retinoscopy values were found in cooperative children ($P$=0.032), yielding a statistically significant difference. Statistical analysis was done by F test. Hyperopic correction determined by best VEP curve was correlated with the values obtained by cycloplegic retinoscopy and with best subjectively accepted hyperopic correction in cooperative children.

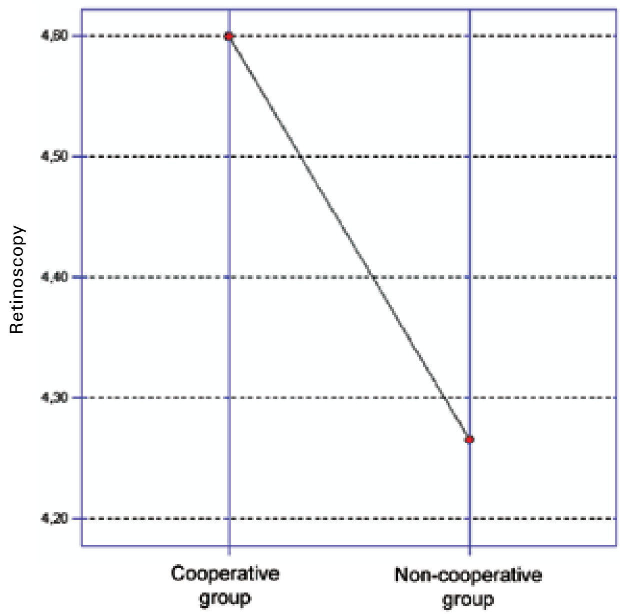


*Fig. 1. Values of retinoscopy in both groups.*

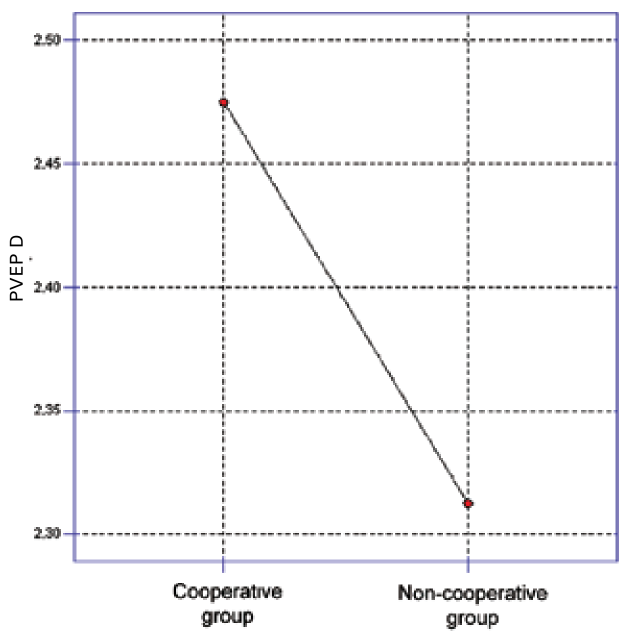


*Fig. 2. Refractive state determined by VEP examination.*

The mean value of correction warranting the best VEP curve was 2.31 D ±0.83 in uncooperative group, and 2.47 D ±0.71 in cooperative group (Fig. 2); the difference was not statistically significant ($P$=0.187).

High linear correlation coefficient was obtained by correlating refractive error obtained by best VEP those obtained by subjective visual acuity examination in cooperative children, with statistical significance at $P<0.001$ (Fig. 4).

Complete correspondence of refractive error found by best VEP curve method and subjective method

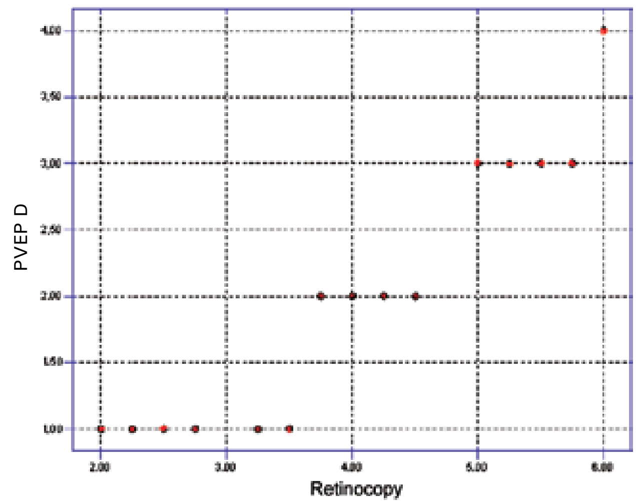


*Fig. 3. Correlation between best VEP curve correction and retinoscopy in both groups.*

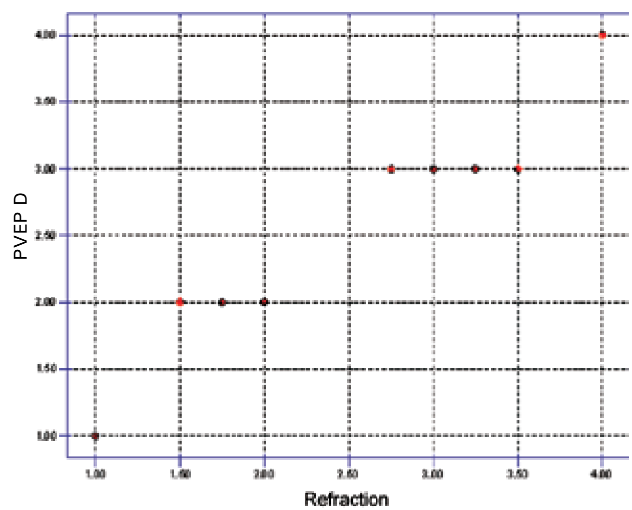


*Fig. 4. Correlation of correction obtained by best VEP curve and best subjective refraction in the group of cooperative children.*

curve and retinoscopy in both groups (r=0.963), yielding very high positive correlation with statistical significance at $P\leq0.001$ (Fig. 3).

High linear correlation coefficient (r=0.979) was obtained by correlating best VEP curve values with

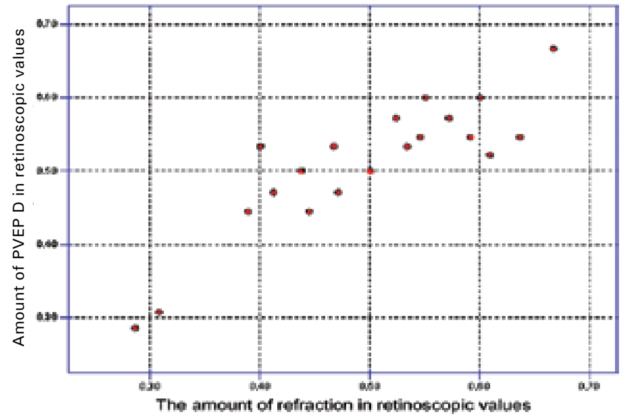


*Fig. 5. Correlation of retinoscopy values corrected by the values obtained by the best VEP curve method and subjective refraction method in cooperative children.*

was recorded in 50 eyes, while 24 eyes had subjective refractive values by +0.25 D higher than those obtained by best VEP curve method; it was by +0.50 D higher, +0.50 D lower, and +0.25 D lower in 2 eyes each (Table 1).

We obtained high linear correlation coefficient (r=0.886) when we correlated the amount of best VEP curve in retinoscopic values with the amount of subjective refraction in retinoscopy values. The level of statistical significance was $P<0.001$ (Fig. 5).

*Table 1. Distribution of correspondence between optimal refraction in cooperative children and those obtained by best VEP curve*

| Subjective refraction (D) | Best VEP curve correction (D) | | | | Total |
|---|---|---|---|---|---|
| | 1.00 | 2.00 | 3.00 | 4.00 | |
| 1.00 | 4 | 0 | 0 | 0 | 4 |
| 1.50 | 0 | 2 | 0 | 0 | 2 |
| 1.75 | 0 | 20 | 0 | 0 | 20 |
| 2.00 | 0 | 18 | 0 | 0 | 18 |
| 2.75 | 0 | 0 | 4 | 0 | 4 |
| 3.00 | 0 | 0 | 22 | 0 | 22 |
| 3.25 | 0 | 0 | 2 | 0 | 2 |
| 3.50 | 0 | 0 | 2 | 0 | 2 |
| 4.00 | 0 | 0 | 0 | 6 | 6 |
| Total | 4 | 40 | 30 | 6 | 80 |

## Discussion

Based on the experience with children with developmental difficulties, we wondered if the prescribed refraction was exact, especially in case of children that cannot cooperate during examination. None of the available methods of investigation of the refractive state of the eye can answer this issue in uncooperative children. Most frequently, the prescription of glasses is based on retinoscopy findings, but we cannot determine if this correction provides best vision because of the patient's uncooperativeness.

The group of cooperative children served for evaluation of the correlation between the correction that warranted best VEP curve and subjective correction the child indicated as providing best visual acuity. We tested between-group differences in all parameters in order to be able to use cooperative children as a control group. A significant difference was only found in the values of hypermetropia, while other parameters did not vary significantly (VEP amplitude and latencies, monocular and binocular, as part of best VEP curve correction in retinoscopy values). We compared data obtained by monocular and binocular testing. Binocular testing results were higher than monocular ones. This kind of visual acuity testing proved as a good method in children whose visual acuity could not be evaluated by subjective refractive methods[11]. These results confirmed that visual acuity and refraction could be determined by VEP testing in uncooperative children.

Some authors found the VEP curve parameters to change according to the refractive state of the eye[11-15]. We also used VEP because it is a noninvasive and painless method[16]. Upon determination of the refractive state of the eye by other objective methods, we checked prescribed refraction by following the change in VEP P100 wave amplitude and prescribed the correction for which these values were highest. In conclusion, we confirmed what other authors had described before, that VEP curve parameters depend on the refractive state of the eye.

P100 wave amplitude values varied significantly by adding hypermetropic correction, but their latencies did not. The curve with highest P100 wave amplitude was selected as optimal correction and it corresponded to subjective refraction values in cooperative children. This study proved a high correlation of refraction, which had highest P100 wave amplitude with subjective refraction values. There was also high correlation between best P100 wave correction and retinoscopy values in both groups. Therefore, we may conclude that the correction that warrants highest P100 wave amplitude is the one that provides best visual acuity in uncooperative children.

We found no previous reports on VEP curve changes in hyperopic children with developmental difficulties. We did not find any correlation between these parameters in healthy children and those with developmental difficulties. That is why we chose these two groups, in order to be able to determine if there are any differences in baseline VEP parameters between the two groups, which allowed us to compare the subjective refraction method in hyperopic children with the best VEP curve method. As we demonstrated that the hyperopic refraction values in retinoscopy values obtained in cooperative children corresponded to the values obtained by the best VEP curve method, it would suggest that hyperopic correction could be objectively determined in children with developmental difficulties. Our study showed the best VEP curve method to be a reliable method to determine refractive state in ametropes.

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Sažetak

## PROCJENA TOČNOSTI KOREKCIJE HIPEROPIJE NA OSNOVI RETINOSKOPIJE I VIDNIH EVOCIRANIH POTENCIJALA KOD DJECE S TEŠKOĆAMA U RAZVOJU

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Cilj ovoga rada bio je ispitati mogućnost procjene optimalne hipermteropne korekcije na temelju ispitivanja vidno evociranim potencijalima (VEP) kod djece koja ne surađuju s ispitivačem. Povezanost između vidne oštrine i VEP istraživala se u samo nekoliko studija, osobito kod mlađe hipermetropne djece. Obradili smo 80 hipermetropne djece (160 očiju) podijeljene u dvije skupine. U prvoj skupini bila su djeca koja surađuju s ispitivačem (kontrolna skupina), a u drugoj skupini bila su djeca koja ne surađuju s ispitivačem. Nakon što se refrakcija ispitala drugim objektivnim metodama, provjeravala se propisana korekcija refrakcije na temelju najviše vrijednosti amplitude P100 vala krivulje VEP. Prva krivulja VEP napravljena je bez korekcije, a ostale krivulje dobivene su uz povećanje hiperopijske korekcije, u okviru skijaskopskog nalaza od +1 D do +6 D s povećanjem od po 1 D. Bilježile su se vrijednosti dobivenih krivulja s najvišom amplitudom i najkraćim vremenom (latencija) vala P100. Krivulja koja je imala najkraće vrijeme i najvišu amplitudu vala P100 označena je kao "najbolja". Ovaj rad potvrdio je mogućnost uporabe VEP u svrhu utvrđivanja najbolje prihvaćene hiperopijske korekcije za propisivanje naočala kod djece koja ne surađuju s ispitivačem. Time se može potvrditi povezanost vrijednosti parametara krivulje VEP s refrakcijskim stanjem oka.

Ključne riječi: *Vidna oštrina; Evocirani potencijali, vidni; Dijete; Vidni poremećaji – fiziopatologija; Vid, očni – fiziologija*