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Original Article

Improved Reading Performance in Patients with Congenital Nystagmus fitted with Soft Contact Lenses

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Purpose: To investigate if soft contact lens wear improves visual function, specifically reading performance, in patients with vision loss due to congenital nystagmus.
Methods: Three low vision patients (15-18 years of age) with congenital nystagmus from retinopathy of prematurity (ROP), optic nerve hypoplasia (ONH), and congenital cataracts (CC), respectively, participated in this study. Refraction was performed to obtain the BCVA (best corrected visual acuity) before and after contact lens fitting. Semi-scleral soft lenses with a base curve of 8.3 or 8.6mm were used. In two cases, soft contact lenses were prescribed in conjunction with spectacles with color filters. Five dependent variables were examined: (1) BCVA (in logMAR), (2) nystagmus frequency (times/sec), (3) nystagmus amplitude (mm), (4) reading duration (min), and (5) reading error (words/session). Recording of data was carried out five times per week, Monday through Friday, at baseline and at first, second and third weeks after lens wear.
Results: All three patients showed improvement after spectacle or contact lens correction. The ONH case alone showed significant improvement in BCVA between pre and post contact lens wear with decreases in nystagmus frequency ($F=6.857$, $p= 0.004$) and amplitude ($F=39.057$, $p < 0.001$) post contact wear. In all cases, contact lens wear proved effective in increasing reading duration (ROP: $F=54.729$, $p < 0.001$; ONH: $F=24.236$, $p < 0.001$; CC: $F=7.602$, $p= 0.002$) and decreasing reading error (ROP: $F=11.142$, $p < 0.001$; ONH: $F=50.743$, $p < 0.001$; CC: $F=30.838$, $p < 0.001$). In addition, all patients reported reduced glare disability and chromatic aberration..
Conclusions: Our results showed that soft lens wear improves reading performance and, in the OHN case, dampens nystagmus. These effects appear to result predominantly from higher foveation quality and broadening of gaze angles, as well as, in part, from improvement in visual acuity and stimulation of the afferent sensory nerves.

Key words: contact lens, low vision, nystagmus

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Introduction

The fovea is a part of the eye, located in the center of the macula region of the retina, that is responsible for sharp central vision[1-2]. By disrupting steady fixation, nystagmus degrades

vision[3-5]. Nystagmus is characterized by an involuntary movement of the eyes, which may reduce vision or be associated with other conditions that limit vision[6].

One of the most common types of nystagmus is congenital nystagmus (CN). People with CN may be only partially sighted or even legally blind[7]. Retinopathy of prematurity (ROP), optic nerve hypoplasia (ONH), congenital cataracts (CC), or other congenital visual system disease may accompany nystagmus[8]. Clinical diagnosis depends on types, amplitude and frequency of nystagmus symptoms and must consider changes in focal distance, direction of gaze, and monocular or binocular viewing conditions[5-6].

The main and first step in the clinical treatment of nystagmus is the promotion of patient visual acuity. Contact lenses can correct for certain abnormalities of the eye that cannot be corrected for with spectacles[9-10]. Moreover, several studies have suggested that contact lenses improve the visual function of patients with congenital nystagmus via neurological feedback[11-14]. As the contact lens moves with the eye, the patient looks along the visual axis of the corrective lens for a far greater proportion of the time than with spectacles. In addition, contact lenses may allow for more stable fixation, reducing the spherical and chromatic aberration and the prismatic effect of spectacles[11,12,15]. Moreover, contact lenses generate additional vergence and accommodative efforts, which may decrease nystagmus amplitude and frequency in some patients[9-14].

Most past studies have used rigid contact lenses to treat nystagmus. The purpose of this study was to investigate if soft contact lens wear improves visual function, specifically the reading performance, of patients with vision loss from congenital nystagmus. Reading performance includes word recognition, reading comprehension, reading rate, and eye fatigue. Reading performance in this study was measured by reading duration and the number of missed words[16-18].

Methodology

Three low vision patients, 15-18 years of age, with congenital nystagmus were prospectively included in our study. Subjects were excluded if they were not willing to use or incapable of using contact lenses (due to poor hygiene, poor compliance, or corneal disease) or if they had multi-ocular disease sufficient to cause visual acuity. This study was reviewed and approved on ethical grounds by the Institutional Review Board (IRB) of Chung Shan Medical University. The IRB adheres to the Declaration of Helsinki regarding human research. All subjects were educated and informed regarding the procedures and gave written consent.

The three participants underwent complete baseline ocular and reading performance evaluations, including slit lamp examination, retinoscopy refraction, best corrective visual acuity (BCVA), characterization of nystagmus (frequency: times/sec and amplitude: mm), reading duration (min), and reading errors (words/session). This study was divided into three stages: stage 1 without any correction; stage 2 with prescription for general spectacle correction plus filter lens, and stage 3 with prescription for soft contact lenses plus filter lens from stage 2. In the first stage of evaluation, recording of data was performed with uncorrected vision. In the second stage of evaluation, there was recording of similar data with subjective refraction to create the prescription for BCVA, including refractive error power, color and density of filter lenses. In the third stage of evaluation, spectacle prescription was replaced or used in conjunction with soft contact lens prescription.

Eye movement and nystagmus recordings were performed at each visit using infrared eye tracker with automatic reading analysis (ReadAlyzer, Stockholm, Sweden). After adjustment, each patient read a storybook with spectacles at baseline and with contact lenses at first, second and third weeks after lens prescription. In addition, reading performance, including reading duration and reading errors, was recorded. All patients were instructed to wear their contact lenses during the study, and recording of data was carried out five times per week, Monday through Friday. To avoid learning effect, four versions of a storybook were selected by junior high school teachers with the

same levels of identification (r=0.44~0.53) and difficulty (P=0.48-0.51). The averages of baseline and first to third week post contact lens prescription recordings were analyzed by one-way ANOVA using the SPSS 18 package.

Results

Case descriptions (Table 1)

Case 1 was a 16-year-old female with visual limitation resulting from ROP. Profound myopia and astigmatism did not improve with corrective lenses (DVA logMAR=1.10, NVA logMAR= 1.00), except with yellow filter lenses (DVA logMAR=1.04, NVA logMAR=0.90). Plano soft contact lenses plus yellow filter goggles were prescribed.

Case 2 was a 15-year-old male with visual limitation resulting from ONH. Treatment of astigmatism promoted his distance visual acuity from 1.22 to 0.80 and near visual acuity from 1.10 to 0.60. There was no positive feedback using filter lenses. Soft Toric contact lens prescription resulted in better visual acuity (DVA logMAR=0.70, NVA logMAR=0.5).

Case 3 was an 18-year-old male with visual limitation resulting from CC. Treatment of hyperopia, astigmatism and photophobia promoted his distance visual acuity from 1.00 to 0.50 and near visual acuity from 0.8 to 0.40.

Statistical results (Table 2 and Fig. 1)

Although only the ONH case showed improvement in BCVA between pre and post contact lens wear, all patients reported better

Table 1. DVA and NVA performance at different prescription

		Refractive errors	DVA (logMAR)	NVA (logMAR)	
ROP 16y Female	VAsc	Retinoscopy OD: -11.75 -1.75 x 043 OS: -8.25 -3.75 x 002	VAsc 1.10	VAsc 1.00	
	Pre-	Spectacles No positive response yellow filter spectacles	1.10 1.04	1.00 0.90	NS
	Post-	Soft sontact lenses Plano Soft CL + yellow filter spectacles	1.04	0.90	NS
ONH 15y Male	VAsc	Retinoscopy OD: PL -2.25 x 111 OS: PL -2.00 x 078	VAsc 1.22	VAsc 1.10	
	Pre-	Spectacles OD: PL -2.00 x 111 OS: PL -2.00 x 078	0.80	0.6	p< 0.05
	Post-	Soft sontact lenses Soft Toric CL	0.70	0.5	p< 0.05
CC 18y Male	VAsc	Retinoscopy OD: +1.75 -1.00 x 148 OS: +1.50 -0.50 x 012	VAsc 1.00	VAsc 0.8	
	Pre-	Spectacles OD: +2.00 -1.50 x 148 OS: +1.75 -0.50 x 012 orange filter spectacles	0.6 0.5	0.5 0.4	NS
	Post-	Soft sontact lenses Soft Toric CL orange filter spectacles	0.5	0.4	NS

VAsc, uncorrective visual acuity;
Pre-, corrective visual acuity before wearing contact lens;
Post-, corrective visual acuity after wearing Contact lens;
ROP, retinopathy of prematurity; ONH, optic nerve hypoplasia; CC, congenital cataracts;
NS, no significant different when comparing with uncorrection

Table 2. ANOVA analysis about characterization of the nystagmus and reading performance

		number	Frequency times/sec		Amplitude mm		Reading duration Min		Reading missing words	
			Means	SD	Means	SD	Means	SD	Means	SD
ROP	baseline	5	4.80	.447	1.76	.261	12.40	2.301	6.80	1.789
	1st week	5	4.60	.548	1.60	.200	23.40	1.342	6.00	1.414
	2nd week	5	4.60	.548	1.48	.130	25.00	.707	3.40	1.140
	3rd week	5	4.00	.707	1.50	.100	26.40	2.702	2.60	.894
			NS		NS		p<0.001		p<0.001	
ONH	baseline	5	3.80	.837	1.54	.114	14.20	1.643	10.60	1.140
	1st week	5	2.00	.707	1.10	.071	22.00	1.581	7.60	.894
	2nd week	5	2.00	.707	1.06	.089	22.80	2.280	5.20	.447
	3rd week	5	1.40	.548	1.04	.055	25.40	2.966	3.80	1.095
			p= 0.004		p<0.001		p<0.001		p<0.001	
CC	baseline	5	1.80	.447	1.54	.207	21.80	2.049	3.80	1.304
	1st week	5	1.60	.548	1.32	.164	23.00	2.449	5.20	.837
	2nd week	5	1.60	.548	1.38	.148	27.80	1.924	.60	.894
	3rd week	5	1.20	.447	1.42	.084	27.20	3.114	.60	.548
			NS		NS		p= 0.002		p<0.001	

NS, no significant different when comparing with baseline
ROP, retinopathy of prematurity; ONH, optic nerve hypoplasia; CC, congenital cataracts

vision with prescribed spectacles, filter lenses, and contact lenses. In addition, all patients reported reduced glare disability and chromatic aberration, especially after contact lens fitting.

Only the ONH patient experienced significant decreases in nystagmus frequency (F=10.797, p= .000) and amplitude (F=39.057, p= 0.000). In all cases, contact lens wear proved effective in increasing reading duration (ROP: F=54.729, p= 0.000; ONH: F=24.236, p= 0.000; CC: F=7.602, p= 0.002) and decreasing reading errors (ROP: F=11.142, p= 0.000; ONH: F=50.743, p= 0.000; CC: F=30.838, p= 0.000). Our results showed that soft lens wear improves reading performance and, in the OHN case, dampens nystagmus. These effects appeared to result predominantly from higher foveation quality and broadening of gaze angles, as well as, in part, from improvement in visual acuity and stimulation of the afferent sensory nerves.

Conclusion

Promoting visual acuity decreases the symptoms of nystagmus. Fitting such patients with contact lenses is not particularly complex or challenging, but it is currently uncommon. Practitioners may shy away from fitting patients with symptoms of nystagmus, achromatopsia, glare, photophobia, aberration, and relatively poor visual acuity, citing that BCVA can be achieved with spectacles. The results of this study prove the importance of refractive correction[9-10]. The comfort and cosmetic benefits of contact lenses can significantly improve the quality of life of patients with symptoms of nystagmus. This is consistent with biological research that nystagmus stability improves reading duration and reduces reading errors[16-18] due to neurological feedback distribution[11-14]. As such, we encourage practitioners to embrace complex contact lens fitting, as the rewards can be massive. Convex lenses can be used for hyperopia correction and concave lenses for myopia correction. Further studies are needed to investigate the differences between rigid and soft contact lenses and between hyperopia and myopia, as well as among nystagmus types.

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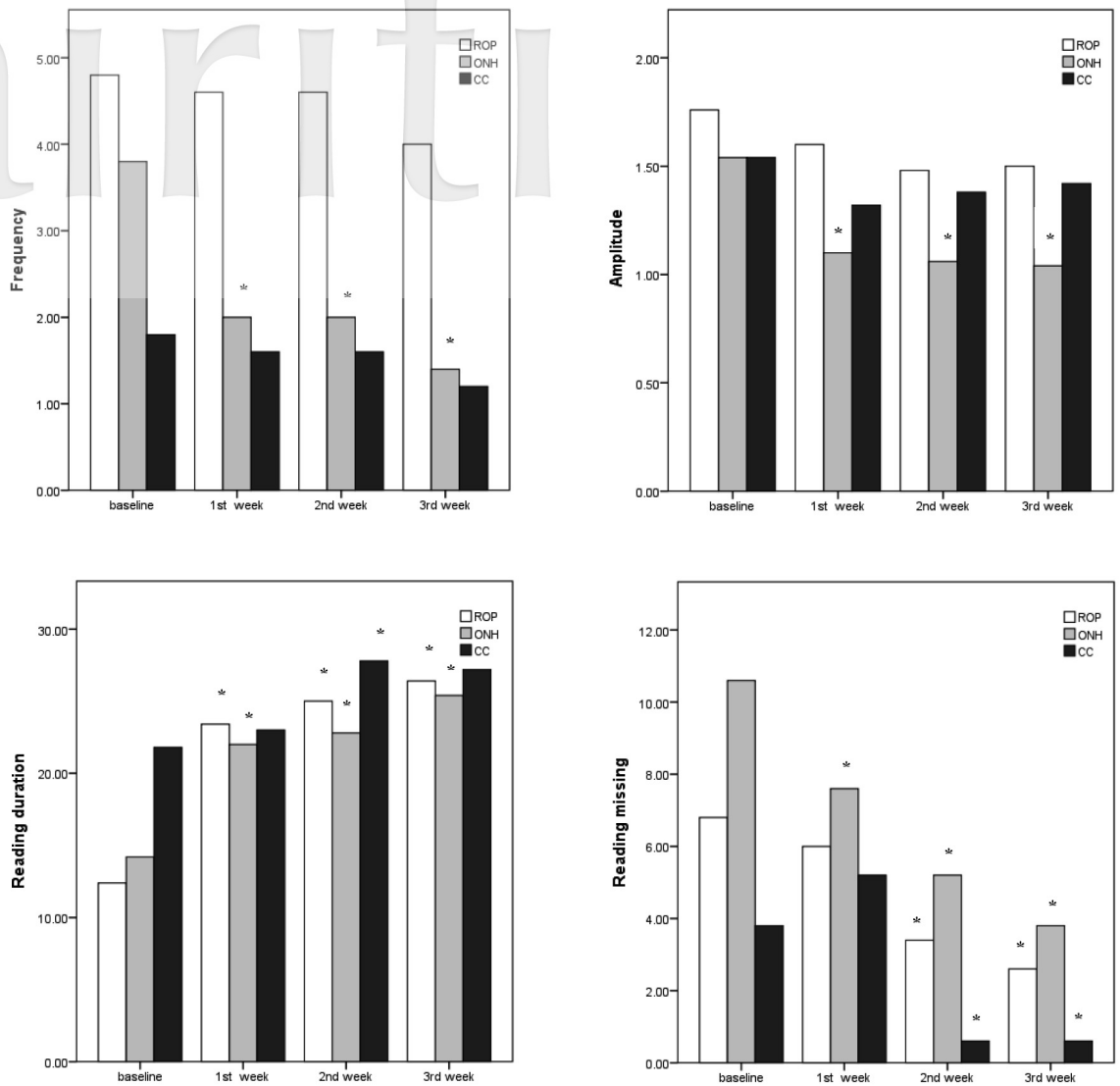

Fig. 1. characterization of the nystagmus and reading performance
(*, significant different when comparing with baseline ROP, retinopathy of prematurity; ONH, optic nerve hypoplasia; CC, congenital cataracts)

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