Effect of Photorefractive Keratectomy on Nystagmus and Visual Functions in Myopic Patients With Infantile Nystagmus Syndrome

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• PURPOSE: To determine the effect of photorefractive keratectomy (PRK) on involuntary eye movements, visual acuity, and contrast sensitivity in myopic patients with infantile nystagmus syndrome.

• DESIGN: Prospective interventional case series.

• METHODS: This study was conducted on patients with infantile nystagmus syndrome and myopia equal to or more than −1 diopter (D), who were referred to our clinic over a 2-year period. Patients older than 18 years of age with a stable refraction for at least 1 year who were good candidates for PRK were included. Complete ophthalmologic examinations including assessment of best-corrected visual acuity (BCVA), contrast sensitivity, and videonystagmography were performed for all patients before and 3 months after surgery.

• RESULTS: Twenty-four eyes of 12 patients with mean age of 23 ± 2 years were enrolled in this study. Spherical equivalent refractive error was −2.82 ± 1.65 D and −0.26 ± 0.25 D before and after PRK, respectively ($P < .001$). Monocular BCVA improved from 0.36 ± 0.21 logMAR to 0.27 ± 0.25 logMAR and binocular BCVA improved from 0.33 ± 0.2 logMAR to 0.17 ± 0.16 logMAR ($P < .001$). Contrast sensitivity significantly improved at low ($P < .001$), intermediate ($P < .001$), and high frequencies ($P = .01$). The frequency, amplitude, and intensity of nystagmus were significantly decreased after PRK ($P < .001$). There was no correlation between the degree of myopia correction and improvement in sensory and motor indices of nystagmus ($P > .1$, Spearman correlation coefficient).

• CONCLUSION: PRK in patients with infantile nystagmus syndrome and myopia improved monocular and binocular BCVA and contrast sensitivity. Furthermore, motor indices of nystagmus (frequency, amplitude, and intensity) were significantly improved after surgery in these patients. (Am J Ophthalmol 2016;162:167–172. © 2016 by Elsevier Inc. All rights reserved.)

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NYSTAGMUS REFERS TO INVOLUNTARY EYE MOVEments that are usually in the horizontal axis but can also be vertical or torsional.[1] According to the speed of the fast and slow phases, nystagmus is classified as pendular or jerky and, based on the time of onset, into congenital (or infantile) and acquired types.[1–4]

Infantile nystagmus syndrome may be further classified into sensory and motor types. In patients with sensory type, there is a recognizable structural abnormality leading to decreased vision, while in the motor or idiopathic type, structural abnormalities are typically absent. Affected patients often have a decreased visual function even though they may have a near-normal visual acuity.[1,2] The intensity of nystagmus often has a reverse correlation with visual acuity in these patients.[5–7] Decreased foveation time is a main cause of decreased vision in these patients and has a direct relation to the intensity of nystagmus.[5–7]

A number of treatment modalities have been used in infantile nystagmus syndrome; these include glasses, contact lenses, prisms, medications, biofeedback, and acupuncture.[8–10] Different surgical methods have also been used for treatment of this condition; most of them are concentrated on extraocular muscle surgery to dampen nystagmus.[11–14] Keratorefractive surgery has been reported to be effective for correction of refractive errors and improvement of vision in nystagmus patients; however, the total number of reported cases is limited to 20 patients across 5 reports.[15–19] For the first time in 1998, Siganos and associates performed photorefractive keratectomy (PRK) in 2 patients with nystagmus.[15] Thereafter, a few case reports of laser-assisted in situ keratomileusis (LASIK) were published in eyes with nystagmus.[16,17] Mahler and associates in 2006 reported 8 cases of femtosecond LASIK in subjects with nystagmus, and vision improved in most of them.[18] Barbara and associates performed LASIK on 8 eyes and PRK on 1 eye with nystagmus and reported improvement of vision in one-third and stable vision in two-thirds of cases.[19]

The purpose of this study is to evaluate the effect of PRK on visual functions and motor characteristics of

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involuntary eye movements in patients with infantile nystagmus syndrome and myopic refractive error.

METHODS

IN THIS PROSPECTIVE INTERVENTIONAL CASE SERIES, PAtients with infantile nystagmus syndrome and myopia more than −1 diopter (D) were sequentially included. The study was performed over a 2-year period from October 2012 to October 2014. The study protocol was confirmed by the ethics and scientific committees of the Ophthalmic Research Center, Shahid Beheshti University of Medical Sciences. The research adhered to the tenets of the Declaration of Helsinki. Informed written consent was obtained from all subjects. Patients older than 18 years of age with a stable refraction for at least 1 year who had detectable Snellen best-corrected visual acuity (BCVA) of at least 20/200 were included. Patients with neurologic problems or any history of eye surgery (including eye muscle surgery) or ocular surface diseases, and also patients with any contraindication to keratorefractive surgery (impossibility of corneal imaging owing to severe nystagmus, inadequate corneal thickness, and inappropriate topographic patterns), were excluded.

In all patients, complete ophthalmologic examinations, including measurement of monocular and binocular visual acuity, refraction, ocular motility and angle of deviation, contrast sensitivity, and anterior and posterior segment evaluations, were performed. Visual acuity was measured using a standard Snellen chart from 6 meters. The monocular vision was measured covering the contralateral eye with a high-power plus lens, adding to the refraction of the patient. Refraction was evaluated without and with cycloplegia (cyclopentolate 1%, 30 minutes after instillation) by the retinoscope.

• **CONTRAST SENSITIVITY MEASUREMENT:** A YANG projector (SIFI Diagnostic SPA, Treviso, Italy) was used to evaluate contrast sensitivity. The screen was placed 50 cm in front of the patients. Contrast sensitivity was evaluated in normal day illumination. Target parallel lines were presented with frequencies of 3, 6, and 12 Hz and contrast was decreased until the patient could not resolve the lines. The minimal resolvable contrast was documented as the contrast sensitivity of the patient in each frequency.

• **VIDEONYSTAGMOGRAPHY:** Videonystagmography (Eye dynamics instrument, Eye Dynamic Inc, Torrance, California, USA) was used for recording the involuntary eye movements. It is an oculomotor module that holds the patient's head while he/she follows the target lights. The target lights are located 20 degrees to the right/left of and up/down from central fixation. Two separate infrared video recording cameras for the 2 eyes are used to record their movements separately. After recording nystagmus movements for 60 seconds, the software of the device calculated the frequency, amplitude, and intensity of nystagmus in the primary position and different gazes. The intensity of the nystagmus was calculated by multiplying its frequency and amplitude.

• **REFRACTIVE SURGERY:** Corneal imaging, including Orbscan tomography (Orbscan, Bausch & Lomb, software version 4.00; Orbtek Inc, Salt Lake City, Utah, USA) and zywave aberrometry (Bausch & Lomb, Rochester, New York, USA) was performed for all patients. Customized PRK was performed by 1 surgeon (A.B.R.) in all cases. The Technolas P excimer laser system (Bausch & Lomb) with an active tracking system was used for all surgeries. We avoided using any instrument for eye fixation during surgeries. After surgery, soft contact lenses were used for 5 days to facilitate epithelial healing. Topical antibiotic (chloramphenicol 0.5%) was continued until complete epithelial healing and steroid drops (betamethasone 0.1%) were continued for 8 weeks on a tapering dose.

The patients were examined on postoperative days 1, 3, and 5, then at 2 weeks and 1 and 2 months after surgery. Repeat BCVA measurement, contrast sensitivity evaluation, and videonystagmography were conducted 3 months after surgery.

• **STATISTICAL ANALYSIS:** To evaluate the normality of distribution of the data, Q-Q plots were used and revealed that the data were not distributed normally. We used mean values, standard deviations, median and range, frequencies, and percentages to present data. In addition, we used the Wilcoxon signed rank test to assess the improvement of nystagmus parameters. Spearman correlation coefficient and 95% confidence intervals were used to correlate the amount of myopia correction with the improvement of sensory and motor indices. All statistical analysis was performed using SPSS software (IBM SPSS Statistics, released 2013; IBM, Armonk, New York, USA). A P value less than .05 was considered as statistically significant.

RESULTS

TWENTY-FOUR EYES OF 12 PATIENTS (6 MALE AND 6 FEMALE) with the mean age of 23 ± 2 years were included. Seven patients (58.3%) were motor type while 5 patients (41.7%) were sensory type infantile nystagmus, including optic nerve hypoplasia (n = 3) and macular hypoplasia secondary to oculocutaneous albinism (n = 2). The mean spherical refractive error before and after surgery was −2.16 ± 1.36 D and −0.1 ± 0.35 D, respectively. The mean spherical equivalent was −2.82 ± 1.65 D and −0.26 ± 0.25 D, and mean astigmatism was −1.33 ± 1.14 D and −0.31 ± 0.51 D before and after surgery, respectively ($P < .001$ for all parameters).