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ORIGINAL ARTICLE

Biometric features and amblyopia risk factors in children with congenital nasolacrimal duct obstruction that underwent probing after 1-year-old

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Abstract

Purpose: The purpose of the study was to evaluate the biometric values of children with congenital nasolacrimal duct obstruction (CNLDO) who underwent nasolacrimal probing after 1-year-old and to determine the effect of probing success and laterality on these values.

Methods: The medical records of children with CNLDO who underwent probing were retrospectively reviewed. Biometric measures (cycloplegic refraction, keratometric data, and axial length measurements), presence of anisometropia, and other amblyopia risk factors were analyzed according to both probing success and laterality. In unilateral cases, the affected eyes were compared with contralateral eyes.

Results: A total of 49 eyes of 39 patients were examined. One or more amblyopia risk factors were detected in 13 (33.3%) patients. Clinically significant anisometropia was detected in six (20.7%) of 29 unilateral cases and two (20%) of 10 bilateral cases. Six eyes of 6 patients (18.8%) among the 32 eyes for which probing was successful and six eyes of 5 patients (35.3%) among the 17 eyes for which probing failed had at least one risk factor with no statistically significant difference between the groups. In unilateral CNLDO cases, the spherical equivalent refraction of the eyes with CNLDO was significantly higher than that of contralateral eyes (p=0.03). However, no significant differences in terms of keratometric or axial length measurements were detected.

Conclusion: The data yielded by this study show amblyopia risk factors in patients with CNLDO regardless of probing results and significantly higher refraction in unilateral CNLDO eyes compared to contralateral eyes.

Keywords: Amblyopia risk factors; biometric features; congenital nasolacrimal duct obstruction; ocular biometric features.

Congenital nasolacrimal duct obstruction (CNLDO), which is characterized by epiphora and discharge, affects 20–30% of all newborns and, in 96% of cases, resolves spontaneously by 1 year of age.[1–3] However, lacrimal system probing, the first surgical procedure used to correct CNLDO, might still be needed in cases with persistent symptoms (approximately 4% of these children).[3] Although this condition is widely considered to be benign, several

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studies have evaluated the relationship between CNLDO and amblyopia risk factors, including anisometropia.[4–12] According to some authors, visual development and emmetropization might be disturbed in children with CNLDO due to persistent epiphora.[4,5] It was also suggested that children with CNLDO and no amblyopia risk factors have an exceedingly small chance of later developing amblyopia or strabismus.[13] However, some researchers reported no significant difference compared to normal population in the prevalence of amblyopia in children with CNLDO.[6] The probability of structural abnormalities, especially in cases in which probing failed and their possible effects on anisometropia, was also reported.[7]

It is possible that biometric values such as keratometric data and axial length measurements which play an important role in emmetropization could be also affected in these children due to some anatomic abnormalities. However, to the best of our knowledge, no studies have evaluated these values in literature. In this study, we aimed to evaluate the biometric values of children with CNLDO who underwent nasolacrimal probing. Moreover, we determined whether refractory obstruction and laterality affected these values.

Materials and Methods

The files of the children with CNLDO who underwent nasolacrimal probing after 1-year-old by the same surgeon were retrospectively evaluated from the medical records. All patients had a positive lacrimal sac regurgitation test before probing. Children with additional ocular or systemic problems that may interfere with normal visual development, ptosis, manifest strabismus, and children with a family history of amblyopia or anisometropia were excluded from the study. Data regarding the patients' age, gender, and course of the treatment were reviewed. Ocular alignment, motility, and anterior and posterior segment findings were recorded. Cyloplegic refractions were measured by applying cyclopentolate 1% eye drops 3 times in each eye within 5-min intervals and examining the results using an auto kerato refractometer (Topcon KR-7000P; Topcon Europe BV, Capelle a/d IJssel, The Netherlands). Corneal power (in diopters [D]) was also measured by the same device, and the mean keratometric values at two principle meridians were noted. Axial length measurements were performed by the same individual using A-scan biometry (Eye Scan; Sonogage, Cleveland, OH, USA; OTI-Scan 1000-B/A/3D; OTI Ophthalmic Technologies, Inc., Toronto, Canada). All measurements were performed by the same author, at the 1st-month control visit following probing.

Amblyopia risk factors, except anisometropia, were accepted based on the American Association for Pediatric Ophthalmology and Strabismus referral criteria guidelines published in 2013 (Table 1).[14] An interocular difference in spherical equivalent cycloplegic refractions of ≥1.5 D indicated anisometropia, in line with previous studies.[4,15,16]

The patients were classified into two groups: Bilateral cases and unilateral eyes. These groups were subdivided into successful probing and failed probing groups for further evaluation of the biometric values and probable increased risk of amblyopia based on initial probing results. The successful probing group included cases with no tearing or

Table 1. American Association for Pediatric Ophthalmology and Strabismus referral criteria guidelines (2013) for amblyopia risk factors[14]

	Refractive risk factors	Refractive risk factors
Age of children	Amblyopia risk factors	All ages
12–30 months	Astigmatism >2.0 D	Media opacity >1 mm
	Manifest strabismus >8 PD in PP	
	Hyperopia >4.5 D	
	Anisometropia >2.5 D	
	Myopia >−3.5 D	
31–48 months	Astigmatism >2.0 D	
	Hyperopia >4.0 D	
	Anisometropia >2.0 D	
	Myopia >−3.0 D	
>48 months	Astigmatism >1.5 D	
	Hyperopia >3.5 D	
	Anisometropia >1.5 D	
	Myopia >−1.5 D	

D: Diopters; PD: Prism diopters; PP: Primary position.

discharge after simple probing, whereas the failed probing group included cases with persistent tearing or discharge after initial probing, requiring other interventions such as nasal endoscopic probing with or without bicanalicular silicone tube intubation and dacryocystorhinostomy. Further, in unilateral group, biometric values of affected eyes were compared with the normal fellow eyes.

Pearson's Chi-square, t-test, paired t-test, Shapiro-Wilk test, and Fisher's exact test were used for statistical analysis. All parents or guardians of the infants studied provided written informed consent to the screening and all assessments. Informed consent forms were obtained from the legal guardians of all patients. The study was approved by a local ethics committee and the research protocol adhered to the Declaration of Helsinki for research involving human subjects.

Results

Forty-nine eyes of 39 consecutive patients who underwent nasolacrimal probing were examined. Of the 39 patients, 17 (43.6%) were male and 22 (56.4%) were female. Ten patients had bilateral CNLDO, 19 patients had unilateral CNLDO in the right eye, and 10 had unilateral CNLDO in the left eye. The mean age at the time of probing was 25.2±14.9 (range: 12–90) months. The mean spherical equivalent refraction (SER) was 1.2±1.4 (range: −1.9–5) D, the mean keratometric value was 43.6±1.5 (range: 40.5–48) D, and the mean axial length measurement was 21.2±0.7 (range: 19.6–22.7) mm in all affected eyes. Overall out of 39 patients, one or more amblyopia risk factors were detected in 13 (33.3%) patients. No patients had myopia or media opacity. Of the children with any amblyopia risk factor, 10 had unilateral, whereas three had bilateral CNLDO.

Clinically significant anisometropia (≥1.5 D) was detected in six (20.7%) unilateral cases and two (20%) bilateral cases. In unilateral anisometrope cases, severe hyperopia or astigmatism was found mostly in the affected eyes (85.7%), suggesting an increased likelihood of ipsilateral amblyopia. Bilateral high refractive error could also be a problem even in unilateral ones, as we detected in 3 children out of 29 unilateral cases.

When amblyopia risk factors were evaluated according to probing success, six eyes of six patients (18.8%) (of the 32 eyes that underwent successful probing) and six eyes of five patients (35.3%) (of the 17 eyes that underwent failed probing) displayed at least one amblyopia risk factor. No statistically significant difference was found between the successful and failed probing groups regarding amblyopia risk factors (Pearson's Chi-square; p=0.45). When patients were evaluated according to the success of probing regarding biometric data, no differences in terms of SER, keratometric data, and axial length measurements were detected (Table 2).

In the 29 cases of unilateral CNLDO, there was no statistically significant difference between biometric values in terms of probing success (p=0.19 for SER; p=0.28 for keratometric values; p=0.79 for axial length measurements; independent t-test). Six of the 23 eyes that underwent successful probing and three of the eight eyes that underwent failed probing displayed at least one amblyopia risk factor. However, no statistically significant difference was found between the successful and failed probing groups in terms of amblyopia risk factors (Pearson's Chi-square; p=0.54).

Table 2. Mean SER, keratometric data, and axial length measurements in successful and failed probing groups

	Probing success		p-value*
	Successful probing (n=32 eyes)	Failed probing (n=17 eyes)	
Mean SER (D)	1.3±1.3 ([−1.87]–5)	1.1±1.5 ([−1.12]–4.25)	0.67
Mean keratometric measurements (D)	43.6±1.5 (40.5–48)	43.6±1.4 (40.8–46)	0.87
Mean axial length measurements (mm)	21.2±0.8 (19.6–20.7)	21.4±0.7 (19.9–22.6)	0.43

*t-test; D: Diopters; mm: Millimeters; SER: Spherical equivalent refractions.

Table 3. Mean SER, keratometric data, and axial length measurements in unilateral CNLDO eyes compared with normal fellow eyes

	Unilateral CNLDO		p-value*
	Eyes with CNLDO	Normal fellow eyes	
Mean SER (D)	1.1±1.3 ([−1.12]–5)	0.9±1.2 ([−1.25]–4.25)	0.030
Mean keratometric measurements (D)	43.6±1.6 (40.5–48)	43.7±1.5 (40.75–47.5)	0.203
Mean axial length measurements (mm)	21.2±0.7 (19.6–22.5)	21.2±0.7 (19.8–22.7)	0.577

*t-test; D: Diopters; mm: Millimeters; SER: Spherical equivalent refractions; CNLDO: Congenital nasolacrimal duct obstruction.

When eyes with unilateral CNLDO were compared to normal eyes, the mean SER was significantly higher in eyes with CNLDO (p=0.03; paired t-test). However, no differences in terms of keratometric data and mean axial length measurements were detected (Table 3).

Discussion

Amblyopia affects approximately 1.6–3.6% of the normal population.[17] Although several population studies have been conducted, the exact prevalence of anisometropia in this age group is unknown. Donahue[16] reported the prevalence of anisometropia in the general pediatric population to be approximately 2%, based on his review of several studies on refractive errors in children at various ages. Giordano et al.[18] reported that the Baltimore Pediatric Eye Disease Study revealed the prevalence of anisometropia (≥1 D) was 2.4% among African-American children and 3.9% among white children aged between 6 and 72 months. The Multi-Ethnic Pediatric Eye Disease Study found that the prevalence of anisometropia was 4.3% among Hispanic subjects and 4.2% among African-American subjects.[19]

CNLDO is generally considered to be a relatively benign condition that does not affect visual maturation. Ellis et al.[6] found no evidence suggesting that visual maturation is adversely affected by allowing spontaneous resolution of CNLDO. They reported no correlation between refractive errors and CNLDO and no significantly increased incidence of anisometropia, amblyopia (1.6%), or strabismus (4.2%) in a large series of 2249 patients with CNLDO, compared with control patients.[6] Similarly, in a recent study, it was reported that there was no evidence to suggest that the prevalence of amblyopia risk factors is higher in CNLDO patients compared with normal controls. The authors also found no difference in the rate of anisometropia between patients with unilateral and bilateral CNLDO.[20] However, some other studies reported that children with CNLDO display amblyopia risk factors, especially anisometropia, more frequently than the general population.[4,7–10,13]

In a recent study of more than 1,200 patients with CNLDO, Kipp et al.[10] stated that there is an association between unilateral CNLDO and the development of anisometropia. They found that anisometropia is twice as likely to occur in unilateral patients (3.6%) and showed a significant relationship between same-sided CNLDO and higher hyperopia. In another study, Piotrowsky et al.[4] described a 9.8% prevalence of anisometropia higher than that of the general population with or without amblyopia in a series of 305 CNLDO patients, with 26 of 30 patients developing hyperopic anisometropia and almost 90% presenting with same-sided CNLDO in the more hyperopic eye. Amblyopia risk factors were present in 13.1% of the patients. Matta et al.[8] identified amblyopia risk factors in 22% of CNLDO patients, whereas Badakere et al.[21] found the same ratio as 14% in unilateral cases. Moreover, Ozgur et al.[22] reported that 27.5% of children undergoing nasolacrimal duct irrigation and probing had amblyopia risk factors, which is consistent with the present study.

Of the 39 patients in our study with CNLDO who required nasal probing, 13 (33.3%) had one or more amblyopia risk factors. The prevalence of anisometropia was 20.5% in our study group. Despite the slightly increased frequency of high astigmatism, hyperopia was not found to be the major causative factor of amblyopia, as reported in earlier studies. However, we observed higher refractive errors, most of which occurred in the affected eye, in concordance with the literature on the relationship between anisometropia and CNLDO. In our study, the presence of both amblyopia risk factors and anisometropia were found to be higher than in the literature. This discrepancy might be due to our study group, which consisted of cases that underwent nasolacrimal probing rather than cases that were spontaneously resolved.

When we compared the successful and failed probing groups, we found the rate of patients with amblyopia risk factors to be 25% and 29%, respectively. Interestingly, all three patients with bilateral CNLDO in the failed probing group had amblyopia risk factors. Although small sample size, bilaterality, and failure in probing together could be effective in a further increase in amblyopia risk.

Researchers have different opinions about the mechanism of anisometropia in children with CNLDO. Chalmers and Griffiths[5] reported 5 cases of anisometropic amblyopia among 130 cases of CNLDO, with more severe hyperopia occurring in eyes with epiphora, suggesting that persistent epiphora may disrupt emmetropization. They stated that accumulation of mucopurulent discharge, excessive tear film, and antibiotic ointments may lead to a lack of proper emmetropization, resulting in greater hyperopia in the affected eye. Improper emmetropization may also occur as a result of associated structural abnormalities, such as maldevelopment on one side of the face that could lead to both an abnormal nasolacrimal duct system and a smaller eye.[5] Piotrowsky et al.[4] hypothesized that distortion of retinal images due to persistent tearing in patients with CNLDO may result in ametropia and that the partial disruption of emmetropization may lead to increased prevalence

of hyperopic anisometropia. Eshraghi et al.[7] stated that the higher prevalence of anisometropia (>1.5 D) (compared to the prevalence in the general population) and the significantly higher spherical equivalents in eyes with CNLDO (compared with contralateral eye) in unilateral cases with CNLDO, especially those that failed probing, may support structural abnormality as an explanation for the possible relationship between CNLDO and anisometropia. Interestingly, it was also reported that patients with early spontaneous resolution of dacryostenosis were more likely to have a higher, not lower, rate of anisometropia than those with late spontaneous or surgical resolution.[23]

In this study, we evaluated biometric data such as corneal power and axial length measurements, which, to the best of our knowledge, had not been considered in earlier literature. We observed that the absolute differences between eyes in terms of keratometric values and axial lengths were more prominent in anisoastigmatic patients. These findings seem to corroborate the theory of partial disruption of emmetropization. It is well known from the literature that CNLDO has a possible relationship with amblyopia. Besides, we also investigated the possible relationship of amblyopia risk factors and biometric measurements with the success of treatment, classifying the patients as successful or failed probing ones. However, prospective studies with long follow-up periods are necessary for further analysis.

The potential limitations of our study include its retrospective study design and small sample size. However, the inclusion of only treated patients older than 1-year-old could be a limiting factor in number cases.

Conclusion

The data gathered in this study suggest a high rate of amblyopia risk factors in patients with CNLDO undergoing nasolacrimal duct irrigation and probing compared to the normal population. This risk as well as the biometric measurements seems to be similar in both successful and failed probing groups. Monitorization of all patients with CNLDO for amblyopia is essential. Amblyopia risk factors might be detected in both eyes, despite the fact that only one eye is probed, or in ipsilateral or contralateral eyes, despite the fact that unilateral probing was performed. A structural abnormality can be possible as an explanation for the possible relationship between CNLDO and anisometropia regardless of probing. However, more research needs to be done to confirm this observation.

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