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Success of Prisms in the Management of Diplopia Due to Fourth Nerve Palsy

Madhura A. Tamhankar, MD, Gui-shuang Ying, PhD, and Nicholas J. Volpe, MD

Scheie Eye Institute, Department of Ophthalmology, University of Pennsylvania, Philadelphia, Pennsylvania.

Abstract

Background—To analyze the success of prism use in alleviating diplopia in patients with fourth nerve palsy and to provide recommendations for prism prescription.

Methods—In this retrospective cohort study, the medical records of 83 patients who were prescribed prisms for symptomatic diplopia due to fourth nerve palsy were analyzed. Data on the nature and duration of diplopia, motility and alignment findings, and amount and type of prism prescribed were recorded. The success of prescribed prismatic correction was assessed by the patient's self-reporting of satisfaction with prism use and follow-up records. The main outcome measure was the satisfaction rate associated with the use of prisms (satisfaction score 1 or 2) in patients with fourth nerve palsy.

Results—There were 69 patients with congenital fourth nerve palsy and 14 patients with acquired fourth nerve palsy who received prisms. The mean primary position ($\pm$ SD) deviation in this group was 7.8 ($\pm$ 4.6) prism diopters (PD). The mean prism prescription was 6 ($\pm$ 2.9) PD. Overall, 92% of patients were satisfied with the use of prisms. During the length of follow-up, which ranged from 2 months to more than 6 years (median: 18 months), 86% of the cohort continued using prisms while 14% of patients underwent strabismus surgery. Among 15 patients who had primary position deviation greater than 15 PD, 80% of the patients reported satisfaction with prisms, and in the 11 patients who received 10 PD or more of prismatic correction, 82% were satisfied.

Conclusion—Prisms are an effective modality for the management of patients with symptomatic diplopia due to fourth nerve palsy. Even in patients with larger deviations including those who were prescribed greater than 10 PD of correction, the success rate of prisms in alleviating diplopia was high. Prisms should be considered as initial therapy in symptomatic patients with fourth nerve palsy.

Prisms are generally recommended for optical correction of symptomatic binocular diplopia (1–4). They alleviate diplopia by altering the path of light rays and aligning the image on the fovea of the deviating eye. Studies reporting data on success of prisms in treating diplopia are limited to a few case series that lack details of ocular misalignment and prism

prescriptions (5–9). It is generally believed that prism glasses are most successful in eliminating diplopia in patients with comitant deviations of less than 10–12 prism diopters (PD), although the success of prisms for deviations greater than 10 PD and for incomitant deviations has not been systematically studied (10).

In this study, we analyzed the satisfaction rates of prisms in 83 patients presenting with fourth nerve palsy.

METHODS

This was a retrospective analysis of medical records of 306 consecutive patients who were prescribed prisms for symptomatic diplopia between 2002 and 2008 from diverse etiologies by a single neuro-ophthalmologist (N.J.V.). Among this group, there were 83 patients with fourth nerve palsy. The study excluded patients who declined therapy secondary to dissatisfaction with prior prism use, desire to have eye muscle surgery, or high costs associated with prism glasses. The patients who had a history of prism use were eligible for the study.

Fourth nerve palsy was diagnosed based on the presence of vertical diplopia that increased in contralateral gaze and/or ipsilateral head tilt (Parks-Bielschowsky 3-step test) (11). Additional features that suggested a congenital basis for a fourth nerve palsy included a history of long-standing intermittent diplopia, presence of facial asymmetry (12,13) (facial hypoplasia due to chronic head tilt), large vertical fusional amplitudes (>6 PD), and presence of inferior oblique overaction. Acquired fourth nerve palsy was diagnosed based on the acute onset of vertical diplopia, poor fusional amplitudes (<6 PD), history of head trauma, and resolution of the palsy on follow-up in some patients.

Evaluation of ocular motility was performed by testing ductions in all directions of gaze. Alignment of the eyes was assessed by cover/uncover, alternate cover, and/or Maddox rod testing. The amplitude of deviation was recorded with prisms, using prism cover test and Maddox rod testing when necessary, in primary position at distance (6 m) and near (33 cm) and in all cardinal gazes. Fusional amplitudes were measured for patients with long-standing deviation, and presence of excyclotorsion was ascertained using double Maddox rod test.

The prisms were prescribed as follows. In general, the minimum amount of prism that would make the patient diplopia free in the primary gaze was prescribed. This was ascertained by moving a prism bar with increasing strength of prisms in front of one eye with the patient fixating on the 20/400 letter “E” on the Snellen chart until the patient reported optimum resolution of diplopia. If the patient felt dissatisfied with the prism, a lesser or higher strength was tried and prescribed. As a general rule, half of the prism dioptic size as measured by the prism cover test in primary position was tried and increased or decreased based on patient’s responses. Usually, the prism strength was split equally between the 2 eyes. Temporary or Fresnel prisms were used in 1 or more of the following situations: 1) if the diplopia was believed to be temporary, 2) in patients who required larger prism strength (>10 D) and in those with greater than 5 PD of lateral incomitance, 3) as an initial trial to assess the effectiveness of prisms prior to prescribing permanent prisms, 4) to take

advantage of the oblique application in patients with combined horizontal and vertical deviation, 5) when there was uncertainty based on patient's responses in clinic, as to the exact prism strength required, and 6) cost considerations due to the fact that temporary prisms are less expensive than ground-in prisms. Fresnel prisms can be used for larger deviations (up to 30 PD) and are lightweight and thin. Additionally, they can be easily mounted to the back of the spectacle lens in the office. The disadvantages of these prisms are the loss of contrast, loss of acuity, scattering of light, and visibility of the grooves that results in blurry vision.

Data extracted from patient records and entered into a Microsoft Access database included type of diplopia (horizontal, vertical, or both) amplitude of deviation, pertinent medical history (including presence or absence of thyroid dysfunction, history of prior strabismus, and ocular, orbital, or neuro-surgical procedures), head and orbital trauma, amount and type of prism (temporary or permanent) prescribed, length of follow-up after prism prescription, and patient electing to proceed with eye muscle surgery. Associated problems resulting from prism use, such as blurred vision, asthenopic symptoms, optical aberrations, poor cosmesis, and persistent diplopia, were noted. All patients must have completed 1 follow-up visit with the neuro-ophthalmologist to be eligible for the study.

The level of satisfaction with prism use was derived from the follow-up records, and a satisfaction score was assigned (Table 1). Those patients who were assigned a score of 1 or 2 were considered successful prism users. Institutional review board approval was obtained for this study.

Standard descriptive data analyses using mean, standard deviations, medians, and ranges were performed for continuous measures, and frequency tabulations were performed for categorical variables. The success rate of prism use was calculated among all the patients with fourth nerve palsy. The association of a demographic or clinical factor with success rate of prism use was tested using Fisher exact test. All data analyses were performed in SAS v9.1 (SAS, Inc, Cary, NC), and 2-sided *P* value < 0.05 was considered to be statistically significant.

RESULTS

The study included 83 patients who had vertical diplopia due to fourth nerve palsy. There were 69 patients with congenital fourth nerve palsy and 14 patients with acquired fourth nerve palsy. The etiology of acquired fourth nerve palsy was closed head injury in 10 patients, 2 of whom were bilateral, 2 from cerebrovascular accident, and 2 were vasculopathic and spontaneously resolved. There were 45 men and 38 women. Their mean age ($\pm$ SD) was 63.6 ($\pm$ 13.8) years. The median length of follow-up after prism prescription was 12 months (range: 2–75 months). The mean vertical deviation and the mean prism prescription are shown in Table 2. The mean amplitude of lateral incomitance was 5.02 PD (SD: 2.86 PD). Twenty-two patients (26.5%) were noted to have an observable head tilt.

Tables 3 and 4 show the satisfaction scores of prism use in patients with fourth nerve palsy. Among 83 patients with fourth nerve palsy, 76 patients (91.5%) are satisfied with the prism

use (95% confidence interval [CI]: 83.6%–95.9%). The success rate was 92.8% (95% CI: 84%–97%) in patients with congenital fourth nerve palsy and 86% (95% CI: 60%–96%) in patients with acquired fourth nerve palsy (Table 3).

The majority of patients were prescribed permanent ground-in prisms ($n = 77$, 92.8%). There were 38 patients who were initially prescribed Fresnel prisms. Thirty-two of these 38 patients later transitioned to ground-in prisms while 6 patients continued with Fresnel prisms. During the follow-up period, which ranged from 2 to 75 months, 85.5% ($n = 71$) of the cohort continued on with prism use while 14.5% ($n = 12$) of patients opted for surgery. There were 7 patients who needed progressive increase in prism strength, and 2 patients, both with acquired fourth nerve palsy, who needed progressive decrease in prism strength. There were 10 patients who had horizontal deviations in conjunction with the fourth nerve palsy. Of these, 3 patients had bilateral fourth nerve palsy and presence of a V pattern esotropia, 4 patients had small amplitude esophoria (less than 4 PD), and 3 had exophoria. In the surgery group, 58.3% (7 of 12) patients reported prior satisfaction with prism use while 5 patients opted for surgery due to dissatisfaction with prisms. Of these 5 patients, 3 had symptomatic torsional component to their diplopia while 2 had primary position vertical deviation greater than 10 PD and had residual diplopia even with prism glasses.

In our patient cohort, there were 11 patients who were prescribed prisms greater than or equal to 10 PD (Table 4). Eighty-two percent of patients in this group reported satisfaction with prism use (score 1 or 2).

We assessed whether there were any demographic or clinical factors predictive of successful prismatic correction (Table 5). The patients older than 65 years had a higher success rate than younger patients (98% vs 84%; $P = 0.04$). The gender, nature and magnitude of diplopia, type and strength of prism, history of prism use, duration of diplopia, and duration of follow-up were not statistically associated with the success of prism use (all $P > 0.05$).

DISCUSSION

We report the success of prisms in the management of a large group of patients with fourth nerve palsy. A literature search for comparable series that have systematically studied the role of prisms in the treatment of symptomatic diplopia due to fourth nerve palsy failed to reveal any similar reports. There are a few reports of patients with fourth nerve palsy in whom a low-power prism prescription effectively treated the diplopia. Bixenman (7) noted success of prisms in 2 patients with congenital fourth nerve palsy who received 1.5 and 6 PD of prism for 4 and 12 PD of hypertropia, respectively. Roodhooft and Van Rens (9) reported 2 patients with congenital fourth nerve palsy who were happy with 3 and 4 PD of prisms prescribed for 4 PD of recorded vertical deviation.

Apers and Bierlaagh (8) described the effectiveness of prisms in 75 patients with paralytic squint, 18 of who had fourth nerve palsy. The success of prisms in alleviation of diplopia was reported to be 53% in all patients with paralytic squint. The fourth nerve palsy group was not analyzed separately. Flanders and Sarkis (5) assessed the effectiveness of Fresnel prisms in 141 patients with horizontal and vertical deviations. These included 55 patients in

whom vertical prism was prescribed. The authors reported an overall success rate of 80%, although the results were not separately reported for the fourth nerve palsy group.

Overall, the success rate of prisms in our cohort was high at 92% (Prism satisfaction score 1 and 2). Patients with congenital fourth nerve palsy had a higher success rate than the acquired group although this did not reach statistical significance.

Patients with congenital fourth nerve palsy received prismatic correction equal to 73% of their primary position deviation while those with acquired palsy received prisms almost equal to their deviation (Table 2). This is likely due to greater fusional amplitudes in the congenital fourth nerve palsy group accounting for lesser amounts of prescribed prism and higher patient satisfaction. We recommend that in congenital fourth nerve palsy patients with good fusional amplitudes, prism prescription equal to 50% of primary position deviation may be initially tried and then adjusted according to prism satisfaction experienced by the patients. In patients with acquired fourth nerve palsy, higher prism prescription almost equal to the primary position deviation may be prescribed.

Although our study included patients who had been previously given prism, 93% success was noted in patients with no previous prismatic correction.

It has been suggested that for larger deviations, prisms may not be as effective since larger prism increases the weight of the glasses, are more unsightly and can cause asthenopic symptoms (7,8). Yet we found that in patients who were prescribed over 10 diopters of prisms (mean: 11.5 PD), over 80% reported satisfaction with prisms. It is therefore recommended that prisms should be tried as initial management even in patients who have large deviations.

Older age was the only factor associated with a satisfaction score that was statistically significant. Differences in gender, type of palsy (congenital or acquired), duration of diplopia, type of prisms (Fresnel or permanent), prior history of prism use and length of follow-up were not associated with greater prism satisfaction scores. Similarly the amount of prism prescribed also was not predictive of the success of prism use. This may be in part due to inadequate sample size of the patients who received larger prism prescriptions.

The limitations of our study include data collection that was performed in a retrospective manner with satisfaction scores derived from the patient's own self-reporting rather than a validated questionnaire of patient satisfaction.

In summary, prisms are an effective therapy for management of patients with diplopia due to fourth nerve palsy. They should be considered in the initial treatment plan for patients with both congenital and acquired fourth nerve palsies including those with large vertical deviations.

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TABLE 1

Prism satisfaction score

1 = Totally satisfied with prism use
2 = Mostly satisfied (generally happy, some residual diplopia, mild asthenopia)
3 = Dissatisfied with prisms (intolerance, ineffective for diplopia)

“Successful prism use” included those patients who were assigned a score of 1 or 2.

TABLE 2

Amplitude of deviation and prism prescription in PD in patients with fourth nerve palsy

Fourth Nerve Palsy	n	Mean Vertical Deviation (SD)	Median Deviation (Range)	Mean Prism Rx (SD)	Median Prism Rx (Range)
Congenital	69	8.25 (4.81)	8 (2–25)	6.07 (2.91)	5 (2–14)
Acquired	14	5.57 (2.74)	5.5 (1–10)	5.54 (2.9)	5.5 (1–12)
Total	83	7.8 (4.62)	6 (1–25)	5.98 (2.9)	5 (1–14)

TABLE 3

Satisfaction rates of prisms in patients with fourth nerve palsy

Fourth Nerve Palsy	n	Totally Satisfied, Prism Satisfaction Score 1, n (%)	Mostly Satisfied, Prism Satisfaction Score 2, n (%)	Dissatisfied, Score 3, n (%)
Congenital	69	52 (75.3)	12 (17.4)	5 (7.25)
Acquired	14	11 (78.5)	1 (7.1)	2 (14.3)
Total	83	63 (76)	13 (15.6)	7 (8.43)

TABLE 4

Mean deviation, mean prism prescription, and prism satisfaction in patients who were prescribed prisms greater than or equal to 10 PD

N (%)	Mean Deviation		Prism Prescription		Score 1, n (%)	Score 2, n (%)	Score 3, n (%)
	Mean (SD)	Median (Minimum, Maximum)	Mean (SD)	Median (Range)			
11 (13.3)	15.4 (5.35)	14 (10, 25)	11.6 (1.75)	12 (10–14)	6 (54.6)	3 (27.3)	2 (18.2)

TABLE 5

Factors associated with success of prism use

Factors	Satisfaction Score 1 or 2,		P *
	n	n (%)	
Age (years)			0.04
<65 (median)	38	32 (84.2)	
65	45	44 (97.8)	
Sex			0.45
Female	38	36 (94.7)	
Male	45	40 (88.9)	
Disease type			0.34
Congenital	69	64 (92.8)	
Acquired	14	12 (85.7)	
Duration of diplopia			1.00
1 year	36	33 (91.7)	
>1 year	47	43 (91.5)	
Amplitude of deviation (PD)			0.20
<10	57	54 (94.7)	
10	26	22 (84.6)	
Amount of prism (diopters)			0.23
<10	72	67 (93.1)	
10	11	9 (81.8)	
Type of prism prescribed			0.21
Fresnel	38	36 (94.7)	
Permanent	45	40 (88.9)	
History of prism use			0.68
No	55	51 (92.7)	
Yes	28	25 (89.3)	
Length of follow-up			0.71
<1 year	41	37 (90.2)	
1 year	42	39 (92.9)	

*
From Fisher exact test.