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Comparison of a Diplopia Questionnaire to the Goldmann Diplopia Field

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Abstract

Purpose—We compared diplopia scores using a new Diplopia Questionnaire to the established Goldmann diplopia field.

Methods—Seventy-five consecutive patients with binocular diplopia associated with any type of strabismus were assessed with the Diplopia Questionnaire and the Goldmann perimeter. Diplopia was scored, according to published protocols, from 0 to 100 where 0 is no diplopia and 100 is diplopia in all measured positions. Where there was a discrepancy of more than 20 points between the Goldmann diplopia field and the Diplopia Questionnaire, two observers classified the reasons for the discrepancies.

Results—There was fair overall agreement between the Diplopia Questionnaire and the Goldmann diplopia field, with 44 (59%) of 75 patients having agreement within 20 points (intraclass correlation coefficient 0.53, 95% CI 0.35–0.68). Of the 31 (41%) of 75 patients who had a discrepancy of more than 20 points, 13 (42%) of 31 exhibited a higher diplopia score with the Diplopia Questionnaire than the Goldmann perimeter and 18 (58%) of 31 showed a higher diplopia score with the Goldmann diplopia field than the Questionnaire. The most frequent reason for a higher Diplopia Questionnaire score was the proximal test distance of the Goldmann diplopia field (6 of 13 cases). The most frequent reason for a higher Goldmann diplopia field score appeared to be patient adaptation to diplopia (9 of 18 cases).

Conclusions—The Diplopia Questionnaire may better represent binocular diplopia in everyday life than the Goldmann perimeter, capturing adaptation to diplopia, suppression, fragile fusion, and diplopia at distance fixation.

Quantification of diplopia provides a means of assessing severity of strabismus and allows evaluation of recovery or deterioration and response to treatment. Until recently, the Goldmann perimeter has been considered the standard for quantifying the field of diplopia, yielding a percentage score.^{1–4} It is not clear how this method of measuring diplopia reflects daily experience or how the derived score correlates with patient's perception of severity.

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No conflicting relationships exist

Recently, a diplopia questionnaire has been designed which assesses diplopia in seven positions of gaze rating diplopia as sometimes, always, or never (Table 1).⁵ The Diplopia Questionnaire is scored in an analogous manner to the Goldmann diplopia field, with primary and reading positions given more weight than other positions, and a percentage score is calculated for each patient. The purpose of this study was to compare the scores obtained using the Goldmann diplopia field with those obtained using the Diplopia Questionnaire and to examine the reasons for any discrepancies.

Subjects and Methods

Institutional Review Board approval was obtained for this study. All procedures and data collection were conducted in a manner compliant with the Health Insurance Portability and Accountability Act (HIPAA). Verbal consent and written HIPAA authorization were obtained for each patient.

Patients

We recruited 76 patients, aged 10 to 85 years, with binocular diplopia associated with a range of ocular motility disorders and visual acuity better than 20/200 (Tables 2 and 3). We have previously reported a comparison of the Cervical Range of Motion (CROM) method to the Goldmann diplopia field in this same group of patients, and data obtained with the Goldmann diplopia field appeared in our previous manuscript.⁶ Of the 76 patients in the original study, one patient did not complete the Diplopia Questionnaire for administrative reasons; therefore, 75 patients are included for analysis in the present report.

Assessing diplopia with the Diplopia Questionnaire

The Diplopia Questionnaire (Table 1) was administered as previously described,⁵ yielding a score from 0 to 25. The score was multiplied by 4 to rescale results from 0 to 100, where 0 indicates no diplopia and 100 indicates diplopia in all positions of gaze.

Assessing diplopia with the Goldmann perimeter

As described as part of a previous study,⁶ we then tested the patients with the Goldmann perimeter (Haag-Streit AG, Keoniz, Switzerland) using the III4e light target as described by Woodruff et al¹ and scored with the weighting template suggested by Sullivan et al,² which places an emphasis on primary position and reading. The test was performed by a trained examiner, and the target was moved from any area of single vision outward along meridians at intervals of 30 degrees. The meridians were followed sequentially, not randomly. Ocular excursions were tested to 60 degrees in all meridians. The Goldmann diplopia field was measured at a distance of 30 cm, in the patient's habitual spectacle correction, and yielded a score from 0 to 100. The field of diplopia, rather than the field of single vision, was recorded in each case.

Analysis

For the purpose of the present study, a difference between test scores of more than 20 points, on the 0 to 100 scale, was defined as a discrepancy. As we have described previously,⁶ the choice of a 20-point difference was somewhat arbitrary, but was based on an evaluation of the proportion of discrepancies occurring at specific thresholds, that is 50-, 40-, 30-, 20- and 10-point differences. When there were more than a 20-point difference, details of the full eye examination in the medical record were reviewed independently by two clinicians (WEA and JMH), in order to determine the cause of the discrepancy. The primary reason for the discrepancy was determined by consensus. An intraclass correlation coefficient (ICC) was calculated for agreement between scores, and a 95% confidence interval (CI) was derived.

Results

Agreement between Goldmann diplopia field and Diplopia Questionnaire

Overall agreement between the Diplopia Questionnaire and the Goldmann diplopia field was fair (ICC=0.53, 95% CI 0.35–0.68). Nevertheless, 31 (41%) of the 75 patients had a more than 20-point discrepancy between the two tests (Figure 1). There were no apparent differences in diagnoses between those with and without a discrepancy (Table 2). Thirteen (42%) of 31 patients had higher scores with the Diplopia Questionnaire than with the Goldmann diplopia field, and 18 (58%) of 31 showed a higher score with the Goldmann diplopia field.

Reasons for discrepancies where Questionnaire score exceeded Goldmann diplopia field score

In the 13 patients who had a higher score with the Diplopia Questionnaire, the most frequent reason was the proximal testing distance of the Goldmann diplopia field (6 of 13 discrepancies, Table 2). This is illustrated in Figure 2 by a patient with a partial 6th nerve palsy and who reported diplopia in most positions of gaze with the Diplopia Questionnaire (score 64), but had a lower score with the Goldman diplopia field (score 22) due to relatively little diplopia at the 30 cm testing distance.

The second most common reason for a higher score with the Diplopia Questionnaire was the presence of suppression using the Goldmann perimeter (3 of 13 discrepancies). This group of patients did not perceive any diplopia during testing with the Goldmann perimeter, but reported diplopia in everyday life. For example, one case with a long standing 3rd nerve palsy had complete suppression when tested with the Goldmann perimeter (score 0), whereas with the Diplopia Questionnaire (score 44) the patient answered “sometimes” for all positions of gaze except reading.

The third cause of a higher score with the Diplopia Questionnaire was poor detection of torsion by the Goldmann diplopia field (2 of 13 discrepancies). The Diplopia Questionnaire requires the patient to describe what is seen in everyday life, and so torsional diplopia is captured by the questionnaire method, whereas the circular white target of the Goldmann perimeter does not detect torsion.

One case had a vertical gaze palsy with 3rd nerve palsy and was unable to follow the Goldmann perimeter target into eccentric gaze positions, underestimating the amount of diplopia present with the Goldmann diplopia field. The last case of discrepancy seemed to overestimate the amount of diplopia experienced when assessed with the Questionnaire, because on clinical examination the diplopia did not appear as widespread as the patient described.

Reasons for discrepancies where Goldmann diplopia field score exceeded Questionnaire score

In 18 (58%) of 31 cases, the Goldmann diplopia field score was higher than the Diplopia Questionnaire score. The most frequent reason for a discrepancy was adaptation to the diplopia in every day life by adoption of an abnormal head posture or avoiding gaze positions (9 of 18 discrepancies). When examined with the Goldmann perimeter the head is positioned straight ahead, eliciting diplopia in the primary gaze position and forcing the patient, in such cases, to use all gaze positions. This is illustrated by a case with Brown syndrome, who used a left head tilt and face turn to maintain single vision in everyday life. The Diplopia Questionnaire score indicated only moderate diplopia (score 52), but with the

Goldmann diplopia field, the compensatory head position could not be adopted and the small area of single vision could not be found (score 100).

The second most common reason for a higher score with the Goldmann diplopia field compared with the Diplopia Questionnaire was an inability to fuse the white light target on a white background, i.e. fragile fusion (4 of 18 discrepancies). With the aid of the peripheral fusion cues, such patients were able to fuse in everyday life, giving a lower score with the Diplopia Questionnaire. This is illustrated in Figure 3 by a patient who had undergone successful surgery for a 4th nerve palsy and was orthophoric in nearly all positions of gaze with minimal torsion (score 12 on questionnaire). This patient could not maintain fusion beyond a few degrees from primary position when tested with the Goldmann perimeter (score 74).

Another reason for a higher score with the Goldmann diplopia field was greater weighting of primary position with the Diplopia Questionnaire compared to the Goldmann diplopia field scoring method (3 of 18 discrepancies). With the Diplopia Questionnaire, primary position accounts for 24% of the total score, whereas with the Goldmann diplopia field template, the area around primary position only accounts for 12% of the total score. Diplopia in the primary position using the current weighting will result in a relatively higher diplopia scores with the Diplopia Questionnaire compared to the Goldmann diplopia field.

A higher score with the Goldmann diplopia field method also occurred secondary to apparent difficulty suppressing the Goldmann light (2 of 18 discrepancies). These patients appeared to be able to suppress diplopia in free space and everyday life, but were unable to suppress the lighted target within the Goldmann perimeter apparatus.

Discussion

In the majority of patients with binocular diplopia, we found fair agreement between diplopia scores obtained with the Diplopia Questionnaire and those obtained with the Goldmann perimeter to assess the diplopia field. Nevertheless, there were notable examples in which the Diplopia Questionnaire seemed to better represent the patient's daily experience than the Goldmann diplopia field, which has implications for monitoring the patient's condition and for clinical management.

Some of the discrepancies between the Goldmann perimeter and the Diplopia Questionnaire could have been predicted based on the physical attributes of the Goldmann perimeter. For example, the proximal testing distance (30 cm) would not adequately represent the patient's daily experience if the diplopia was primarily at distance and not at near, e.g. a mild partial sixth nerve palsy. In such cases, the impact of the diplopia is better assessed by the Diplopia Questionnaire. The testing distance disparity between the Goldmann diplopia field and the Questionnaire is similar to the testing distance disparity demonstrated between the Goldmann diplopia field and the CROM method.⁶ It appears that either the Diplopia Questionnaire or CROM method may better represent the diplopia experienced in sixth nerve palsy in everyday conditions.

Some patients demonstrated suppression when tested with the Goldmann perimeter, yielding a very low diplopia score. Other clinical measures may also underestimate diplopia in a patient with intermittent suppression, because they rely on a single office examination, whereas the Diplopia Questionnaire assesses diplopia over a period of time and in many different situations.

Torsion is poorly detected by the standard circular III4e target on the Goldmann perimeter^{2, 5} and therefore, if there is a torsional component to the patients diplopia, it may

be underestimated. Modification of the circular target to a cross target may eliminate this problem, but such modifications of the Goldmann equipment would limit its use when testing visual fields. Other authors have described alternative methods for assessing torsion while performing a diplopia field, but these require additional personnel.⁷ The Diplopia Questionnaire captures all forms of diplopia including torsional diplopia by direct questioning.

Many patients adapt to their diplopia by adopting a head posture or avoiding particular gaze positions; for example, a fourth nerve palsy or Brown syndrome. If the head posture is not too extreme, the Diplopia Questionnaire would better represent these adaptations, but in extreme cases it could be argued that the head position itself is part of the underlying problem. In such cases of severe head posture, the Goldmann perimeter may be useful in quantifying diplopia when the head is straight.

We have previously suggested that when testing diplopia with the Goldmann perimeter, the white light fixation target inside the white bowl might be difficult to fuse⁶ in cases of fragile fusion (for example following a traumatic head injury). In such cases, the questionnaire may better represent everyday experience, since patients with fragile fusion may recruit peripheral fusion cues in a real world environment. Similarly, we have previously reported that the CROM method is more representative of the patient's diplopia when fusion is fragile.⁶

The Diplopia Questionnaire does have some limitations. Firstly, the questionnaire scoring system weights primary position heavily. Further validation of scoring systems is needed, and such future studies might incorporate health related quality of life measures. Because the Diplopia Questionnaire is subjective, there may be some cases in which a patient's personality might influence the score by being overly negative or overly positive, answering 'always' instead of 'sometimes' or 'sometimes' instead of 'never.' Such perceptions are inherent weaknesses of questionnaires in general.

We have previously reported the results comparing the Goldmann perimeter to the CROM method for quantification of diplopia and have previously highlighted the advantages of the CROM, e.g. portability, ability to assess diplopia in a real world environment, and ability to assess torsional diplopia.⁶ The Diplopia Questionnaire appears to share some of the advantages of the CROM (for example, assessment of distance diplopia and sensitivity to torsional diplopia), but the Diplopia Questionnaire appears to have additional benefits. Firstly, the Diplopia Questionnaire assesses the patients diplopia by asking questions about their daily experiences, so the Questionnaire is sensitive to patient adaptations, such as a head posture or suppression, and this may better reflect the patient's daily experience. Secondly, the Diplopia Questionnaire requires no special equipment, which would make it useful in centers without access to, or resources for, a CROM or Goldmann perimeter, and when assessing severely disabled patients unable to maintain the required head position for the Goldmann perimeter or the CROM.

The Diplopia Questionnaire might not be the best tool to quantify diplopia in some specific situations. For example, if a numerical score was needed immediately before or after a surgical procedure, such as in a surgical trial, the CROM or the Goldmann diplopia field methods might be more discriminatory. Nevertheless, the Diplopia Questionnaire might be useful in long-term surgical follow-up to reflect the overall impact of the surgery on the patient's everyday life.

We found that the Diplopia Questionnaire is a useful tool in quantifying diplopia, asking the patient to report diplopia in seven positions of gaze in their everyday life. The Diplopia Questionnaire captures adaptation, suppression, fragility of fusion, and diplopia at distance

fixation. In many cases, the Diplopia Questionnaire appears to be closer to the everyday experience of the patient than a diplopia field plotted on the Goldmann perimeter. The new Diplopia Questionnaire may be a useful measure for evaluation and monitoring of patients with ocular motility problems, and as an outcome measure for future clinical trials in strabismus.

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References

1. Woodruff G, O'Reilly C, Kraft SP. Functional scoring of the field of binocular single vision in patients with diplopia. *Ophthalmology*. 1987; 94:1554–61. [PubMed: 3431826]
2. Sullivan TJ, Kraft SP, Burack C, O'Reilly C. A functional scoring method for the field of binocular single vision. *Ophthalmology*. 1992; 99:575–81. [PubMed: 1584576]
3. Fitzsimons R, White J. Functional scoring of the field of binocular single vision. *Ophthalmology*. 1990; 97:33–5. [PubMed: 2314839]
4. Feibel RM, Roper-Hall G. Evaluation of the field of binocular single vision in incomitant strabismus. *Am J Ophthalmol*. 1974; 78:800–5. [PubMed: 4425006]
5. Holmes JM, Leske DA, Kupersmith MJ. New methods for quantifying diplopia. *Ophthalmology*. 2005; 112:2035–9. [PubMed: 16185766]
6. Hatt SR, Leske DA, Holmes JM. Comparing Methods of Quantifying Diplopia. *Ophthalmology*. 2007; 114:2316–22. doi:10.1016/j.ophtha.2007.01.033. [PubMed: 17512980]
7. Summers CG, Lavoie JD, Letson RD. Use of a modified binocular visual field to assess cyclodiplopia. *Ophthalmology*. 1987; 94:231–4. [PubMed: 3587898]

Figure 1. Distribution of scores on Diplopia Questionnaire and Goldmann diplopia field showing patients who were within 20 points (shaded grey area, 44 (59%) of 75 patients) and those who had discrepancies of greater than 20 points outside of shaded area (31 (41%) of 75 patients).

Figure 2.

Example of a case in which the testing distance of the Goldmann diplopia field (30 cm) resulted in erroneous underestimation of the patient's diplopia. Patient had a partial sixth nerve palsy with diplopia in most positions of gaze at distance fixation yielding a Questionnaire score 64, whereas little diplopia at 30 cm yielded a Goldmann diplopia field score of 22. Shading represents the area of binocular diplopia.

Figure 3.

Example of a case where inability to fuse the white target on the white background (i.e., fragile fusion) resulted in an overestimation of the diplopia on the Goldmann diplopia field. This patient originally had a bilateral fourth nerve palsy and had successful surgery, being orthophoric nearly in all positions with little complaint of diplopia. The diplopia score on the Goldmann diplopia field was 74 and the Diplopia Questionnaire score was 12. Shading represents the area of binocular diplopia.

Table 1

Diplopia questionnaire—positions of gaze and assigned scores

Gaze positions	Always	Sometimes	Never
Straight ahead	6	3	0
Reading	4	2	0
Up	2	1	0
Down (eg, downstairs)	4	2	0
Right	4	2	0
Left	4	2	0
Any other position	1	1	0

If all “always,” the patient is asked can you get rid of it? (If yes, subtract 1 from total score, ie, 24 of 25)⁵

Total scores range from 0 to 25 and are multiplied by 4 to give a score 0 to 100.

Diagnoses and reasons for discrepancies

Table 2

		Reasons for discrepancies									
		Questionnaire score > Goldmann score					Goldmann score > questionnaire score				
Diagnosis	n (%)	Distance deviation	Suppression with Goldmann	Torsion not detected with Goldmann	Unable to fix beyond 30°***	Patient's perception	Adaptation (head posture)	Difficulty fusing the light	Weighting of primary position	Difficulty/unable to suppress with Goldmann	No discrepancy
abducens nerve palsy	13 (17%)	4	0	0	0	0	1	1	1	2	4
trochlear nerve palsy	21 (28%)	0	1	2	0	1	2	1	0	0	14
oculomotor nerve palsy	6 (8%)	0	1	0	0	0	0	0	1	0	4
Graves eye disease	6 (8%)	0	1	0	0	0	1	0	0	0	4
CPEO ***	1 (1%)	0	0	0	0	0	1	0	0	0	0
Duane syndrome	3 (4%)	0	0	0	0	0	1	0	1	0	1
Brown syndrome	2 (3%)	0	0	0	0	0	1	0	0	0	1
Post scleral buckle	9 (12%)	2	0	0	0	0	0	1	0	0	6
Consecutive strabismus	5 (7%)	0	0	0	0	0	0	1	0	0	4
Divergence insufficiency	3 (4%)	0	0	0	0	0	2	0	0	0	1
Vertical gaze palsy	1 (1%)	0	0	0	1	0	0	0	0	0	0
Other**	5 (7%)	0	0	0	0	0	0	0	0	0	5
Total	75 (100%)	6	3	2	1	1	9	4	3	2	44

Other Diagnoses include: Parinaud's syndrome (n = 1), post scleral plaque (n = 1), post cataract extraction (n = 1), orbital trauma (n = 1), decompensated exophoria (n = 1).

CPEO: chronic progressive external ophthalmoplegia.

** from central fixation in any meridian