Correlation between Worth Four Dot Test Results and Fusional Control in Intermittent Exotropia

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Purpose: To compare the results of Worth 4-dot test (WFDT) performed in dark and light, and at different distances, with fusional control in patients with intermittent exotropia (IXT).

Methods: Dark and light WFDT was performed for new IXT subjects at different distances and the results were compared with level of office-based fusional control.

Results: Fifty IXT patients including 17 male and 33 female subjects participated in the study. A significant difference (P<0.05) was observed between levels of home and office-based fusional control (P<0.05). A weak correlation was present between the results of WFDT and level of office-based fusional control; the highest agreement (Kappa=0.088) was observed with dark WFDT performed at a distance of 4m.

Conclusion: Evaluation of fusional state by far WFDT, especially in a dark room, shows modest correlation with office-based fusional control in IXT patients and can be used as an adjunct to more complex tests such as far stereoacuity.

Keywords: Intermittent Exotropia; Fusion; Worth Four Dot Test

J Ophthalmic Vis Res 2012; 7 (2): 134-138.

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Received: February 10, 2011 Accepted: December 27, 2011

INTRODUCTION

Exotropia is a manifest outward ocular deviation which occurs in 1 to 2% of the pediatric population; intermittent exotropia (IXT) is the most common form of childhood exotropia.1 Non-surgical treatments for this condition include orthoptic eye exercises, part time occlusion, minus lens therapy, and prisms.2-4 There is no consensus on a definite method to specify optimal timing for therapy in IXT patients. Conventionally, intervention has been recommended when the deviation becomes clearly noticeable at home or in the office.

Previous studies on distance stereoacuity in IXT cases have suggested that this parameter improves following surgery. Hence deterioration in distance stereoacuity has been considered as an objective measure of IXT severity and used as a means to evaluate the need for surgery.5-10 Different instruments have been employed for measuring distance stereoacuity in IXT patients but most of them are out of production and no longer widely available; the Baylor visual acuity tester (BVAT) and the binocular vision testing system (Mentor O&O, Norwell, MA, USA) for instance, are currently unavailable.

Some studies on the other hand, do not recommend employing distance stereoacuity thresholds; Holmes et al7 demonstrated that measurable distance stereoacuity thresholds in IXT are highly dependent on the type
of employed tests. Furthermore, isolated measurements of stereoacuity cannot be relied upon as an indicator for IXT severity or its alterations over time when one needs to decide for an appropriate time for intervention.\textsuperscript{11}

Central suppression occurs prior to loss of distance stereoacuity in IXT patients.\textsuperscript{13} The worth 4-dot test (WFDT) evaluates binocular fusion and can be performed in different sizes and at variable distances. Darkness can overcome peripheral fusion and far distance testing can better evaluate central suppression.

In the current study, we compared the results of dark and light WFDT performed at variable distances with the level of office-based fusional control in patients with IXT. We aimed to introduce an easy-to-use and objective method for evaluating patients with IXT.

**METHODS**

Fifty new consecutive IXT patients with no history of surgical or non-surgical therapy who had been referred to the strabismus clinic at Khatam-al-Anbia hospital were enrolled for the purpose of the study. All cases had basic type intermittent exotropia (no more than 10 prism diopter [PD] difference between far and near deviation) with various levels of fusional control. Only cooperative patients were enrolled; other inclusion criteria included uncorrected visual acuity (UCVA) of at least 0.7 (decimal notation) in both eyes, and no more than two lines of difference in visual acuity and less than 2 diopters (D) of anisometropia based on cycloplegic refraction. Informed consent was obtained from the patients or their guardians after explaining the study and its goals.

The amount of ocular deviation was measured with an accommodating target at far (6m) and near (33cm) with a +3.00 lens, and after occlusion of one eye for 30 minutes. Fusional control was assessed utilizing subjective (home control) and objective (office-based control) criteria. Home control was categorized as excellent or good (squint/monocular eye closure seen <50\% of the time when the child is observed for distance viewing), fair (squint/monocular eye closure seen >50\% of the time when the child is observed for distance viewing), and poor (squint/monocular eye closure seen at distance and near fixation). Office-based fusional control was based on the outline suggested by Rosenbaum and Santiago\textsuperscript{12} and categorized as good (deviation becomes manifest only after cover test and fusion resumes without need for blinking or refixation), fair (blinking or refixation is required to control the deviation after cover test), and bad (deviation is manifest spontaneously or any form of disruption of fusion without recovery).

Before disruption of fusion by cover testing, WFDT was performed using 1 red, 2 green and 1 white flashlight dots at different distances of 15cm, 33cm, 50cm and 1, 4 and 6m with the WFDT box under light and dark conditions. To evaluate the correlation between WFDT results and office-based assessment of fusional control, WFDT results were classified into three groups: fusion, suppression and alternate suppression/diplopia.

Kappa coefficient, Kendall Tau test and paired t-test were used to measure the correlation between the aforementioned groups, evaluate differences between home and office-based fusional control levels, and assess differences in the amount of deviation measured by different methods, respectively. All measurements were performed by the same trained optometrist.

**RESULTS**

Fifty consecutive patients with IXT including 17 male and 33 female subjects with mean age of 12.5±3.2 years were enrolled; 28 subjects were 4 to 10 years of age and the rest were older than 10 years. Table 1 displays the angle of deviation in the study participants. The amount of far deviation increased significantly after occlusion of one eye for 30 minutes (P<0.001). Near deviation also increased significantly after the occlusion test, and following the use of a +3 lens (P<0.001). A significant difference (P<0.05) was observed between the results of home and office-based assessment of fusional control (Table 2). Figure 1 displays the correlation between dark and light WFDT performed at different distances with the
results of office-based fusional control; a weak correlation was noted between the results of WFDT and that of office-based fusional control (kappa=0.001 to 0.088). Kappa coefficient was higher in dark than light at almost all distances; the highest kappa coefficient belonged to dark WFDT performed at a distance of 4m (kappa=0.088).

**DISCUSSION**

As demonstrated by Guyton, central suppression occurs before significant loss of distance stereoaucity; some patients who elicit distance stereoaucity on the vectographic contour circle test demonstrate a suppression scotoma. This theory was the rationale behind choosing WFDT...
for evaluating binocular fusion in IXT patients in the current study.

Stimulus angle for the WFDT flashlight at different distances from the subject were: 6 degrees at 33cm, 4 degrees at 50cm, and 2 degrees at 100cm. The distance WFDT subtends 1.25 degrees at 6 meters and slightly more at 4 meters. Suppression size can be estimated by moving the target to a closer distance. Sandra et al\textsuperscript{17} evaluated distance WFDT with variably sized targets and thereby different visual angles. The difference between breakpoint of fusion for distance WFDT as compared to normal subjects was statistically significant; they concluded that the poorer the level of fusional control, the larger the angle of fusion disruption.\textsuperscript{17} In the current study we used WFDT at different distances instead of different sizes. Other variations of the test involve decreasing dissociation with polarization and variable size of the target lights for standardization.\textsuperscript{14,15} Morale SE et al modified the WFDT by replacing the circular lights with shapes friendlier to younger children.\textsuperscript{16}

Conventionally, intervention has been recommended when deviation is noted in at least 50% of waking hours or when there is deterioration of control in near fixation.\textsuperscript{12} One of the simplest rating scales for assessing IXT, is the Newcastle control score (NCS) which was developed by Haggerty et al.\textsuperscript{18} They used modified descriptions of control as outlined by Rosenbaum and Santiago regarding subjective (home control) and objective (clinic-based control) criteria. As they claimed, NCS is a reliable method for grading the severity of IXT and helps to decide on intervention.

As mentioned earlier, central fusion may be damaged before stereoacuity in IXT patients. Devising an artificial situation in the dark may overcome peripheral fusion and performing WFDT at farther distances can better evaluate central suppression. Although the correlation between WFDT and office-based control was not strong in this study, dark WFDT at a distance of 4m had modest correlation. We observed a decrease in the correlation between WFDT and office-based control at 6m which can be the result of decreased test accuracy or poor patient attention at far distances.

In summary we may conclude that dark WFDT at a distance of 4m can be used along with reliable tests such as far stereoacuity and office-based control levels as a readily available test for evaluation of fusional control in IXT patients. Since far stereoacuity tests are not widely available and surgeons cannot rely on home control reports alone, use of an accessible, objective and easy-to-use test could be of great benefit. The next step would be to conduct a study which compares WFDT results in different situations with far stereoacuity tests.

Conflicts of Interest

None.

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