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Evaluation of stereo tests for screening of amblyopia

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Abstract

Background: One of the most dramatic sensory ocular anomalies is the low visual acuity of one eye known as amblyopia. The goal of preschool vision screening is to detect children with amblyopia. Stereopsis is an important indicator of the state of binocularity. Previous studies showed a disagreement on the reliability of stereo tests as screening tools for amblyopia. This study was performed to compare visual acuity testing with the ability of TNO, Titmus and Randot stereo tests for detection of amblyopia.

Methods: A total of 1000 pupils, aged 6-12 years were examined in a field study in Shiraz. In addition to the 3 stereo tests of TNO, Titmus and Randot, the examination included visual acuity, cover testing and inspection of red reflex. According to definite fail pass criteria, abnormal cases were referred to pediatric eye clinic for complete eye physical examination. Similar to the first part, in the second part of the study, 100 amblyopic students aged 6-12 years, were referred to pediatric eye clinic for complete physical examination. Sensitivity and specificity of each stereo test for detection of amblyopia was calculated.

Results: In screening situation, the sensitivity of stereo tests was 55.5% for TNO with a cutoff point of 240", 48.8% for Titmus with a cutoff point of 70" and 44.4% for Randot stereo test with cutoff point of 100". Specificity of these tests in screening situation was 86.9%, 94.4%, and 98.4% respectively. The respective sensitivity of these stereo tests in clinical situation was 74%, 68%, and 62%.

Conclusion: Considering these fail-pass criteria, none of the TNO, Titmus, and Randot stereo tests can be recommended as a screening method for detection of amblyopia in children.

Keywords: Amblyopia; Screening; Stereopsis

Introduction

One of the most dramatic sensory ocular anomalies is the low visual acuity of one eye, known as amblyopia. The prevalence of amblyopia range from 1% to 3.5% in different studies.[1] Amblyopia is the most common entity for referral of children for an eye examination. The goal of preschool vision screening is to detect children with amblyopia.[2]

Stereopsis is an important indicator of the state of binocularity.[2] Theoretically, stereo tests with less sensitivity to simple refractive

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errors, are attractive to use in screening situation. They are much less time-consuming than most of other tests and can be administered by non-ophthalmologist. They are less sensitive to simple refractive errors. They may offer a "system" test of optical and motor, as well as neural components of vision. It appears that stereopsis might be a simple means to determine binocular dysfunction.[2]

Several qualities are required by a test to render it suitable for screening methods. It must be simple to perform and acceptable to the participants, giving a true measurement of the condition it sets out to measure, and to reliably identify those with and without disease, and be cost-effective.[2]

Stereo tests have been suggested to be a fast and reliable method for screening amblyopia and strabismus in children.[3-9] Some authors found more disappointing results with unacceptably high underreferral rates.[2,10-12] Recent reports led to the conclusion that stereopsis testing may be beneficial in the early diagnostic screening of children with amblyopia and strabismus. However, various stereo tests may yield different results.[13]

The aim of present investigation was therefore to systematically compare commercially available stereoscopic tests in normal and patient populations in an attempt to determine their differences and clinical usefulness for detection of amblyopia.

Materials and Methods

The field study included visiting 5 primary schools in various districts of Shiraz where a total of 1000 children (518 boys and 482 girls) in two age groups of 6-7 and 8-11 years were examined within the respective schools by one ophthalmologist. In addition to three stereo tests, TNO, Titmus, and Random dot, the examination also included visual acuity testing with Snellen chart, inspection of the red reflex and posterior pole and cover uncover test. Visual acuity was assessed with Snellen chart. Prescription glasses normally worn by the children were used during the test. All children who did not achieve 20/20 visual acuity in each eye either unaided or with pinhole or else had abnormal range of stereopsis with either test were referred to the pediatric eye clinic. Complete eye examination including dry refraction, cycloplegic refraction, cover-uncover test and evaluation and measurement of strabismus (if present), slit lamp examination and fundoscopy were done for referred children.

The three stereopsis tests performed on first examination at school. All children were tested with all 3 stereo tests. Prescription glasses normally worn by the children were used during the tests. Tests were administered according to instructions in the information manuals provided. The fail-pass thresholds were chosen according to the prescription manuals of each test and suggestions in the previous reports. The fail-pass threshold was 100" for the Titmus test, 70" for the Randot test, and 240" for the TNO test.[2]

Amblyopia was defined as either visual acuity of less than 20/20 with at least 2 lines of inter-ocular difference without any organic cause, or bilateral reduction in visual acuity in presence of high spherical refractive error of <-7D or >+3D and/or cylindrical refractive error of more than 3D.[2]

The second part of the study included 100 amblyopic children referred to pediatric eye clinic. They comprised 48 boys and 52 girls and aged from 6-12 years. Complete eye physical examination including TNO, Titmus and Randot stereo tests similar to the first part of study were performed for them. The same

Table 1: Stereo acuity (seconds of arc) with different tests in 1000 children of 6-12 years old

Test	Population	Male	Female	Group A	Group B
TNO	128.47±114.3	127.8±112.2	129.2±113.4	126.8±114.1	129.4±115.2
Titmus	85.49±32.3	89.3±33.4	81.4±31.7	88.2±31.4	82.4±33.4
Randot	71.70±54.7	73.2±54.2	70.1±55.4	72.7±54.2	71.2±55.7

fail-pass criteria applied. Data analysis was done with SPSS 10 and Epi Info 6 softwares.

Results

The first part of the study was done in screening situation. The population included 1000 students, 482 girls and 518 boys, divided into groups A (485 children aged from 6-7 years) and B (515 students aged from 8-12 years) groups. The prevalence of amblyopia was 4.8% in boys and 4.1% in girls (p=0.7) in group A and 4.5% in group A and 4.4% in group B (p=0.9). The mean of streopsis in this population was 128.4±114.3 seconds of arc with TNO test, 85.5±32.3 seconds of arc with Titmus test and 71.7±54.7 seconds of arc with Randot test. Table 1 shows the mean of stereopsis in different age and gender groups in each stereo test. Amblyopia and strabismus was found in 45 and 20 children respectively. Of 45 pupils with amblyopia, 20 had anisometropic amblyopia, 22 had strabismic amblyopia, one student had unilateral cataract and 2 children presented with traumatic corneal scarring. Abnormal stereo test was found in 15% of the subjects with TNO, in 3.5% with Randot, and in 7.51% with Titmus test (Table 2). The sensitivity of various tests for detection of amblyopia was 55.5% for TNO test, 48.8% for Titmus test, and 44.4% for Randot test (Table 2). All stereo tests were more sensitive in finding strabismic amblyopia than anisometric amblyopia, but the differences were not statistically significant. The specificity of these stereo tests was 86.9% for TNO, 94.4% for Titmus, and 98.4% for Randot test. Of 58 subjects with strabismus and/or amblyopia only 6 children including 3 with strabismic amblyopia, 2 with anisometropic amblyopia and 1 with strabismus were identified by all stereo tests. None of the tests identified 22 subjects with strabismus and/or amblyopia while 18 children did have amblyopia.

The second part of study that was conducted in clinical setting comprised 100 students, aged 6-12 years including 52 boys and 48 girls, selected from pediatric ophthalmology clinic. The mean stereopsis was

Table 2: Abnormal Stereo tests in 1000 children of 6-12 years old

Abnormal test	Total population	Amblyopic patients	Anisometric amblyopia	Strabismic amblyopia
Abnormal TNO	150 (15%)	25 (55.5%)	10 (50%)	14 (63.6%)
Abnormal Titmus	75 (7.5%)	22 (48.8%)	8 (40%)	11 (50%)
Abnormal Randot	35 (3.5%)	20 (44.4%)	8 (40%)	11 (50%)

438±266.2 seconds of arc with TNO, measuring 420±297.3 seconds of arc with Titmus and 388±197.2 seconds of arc with Randot stereo tests. Of cases with amblyopia, 44 were anisometric and 56 represented strabismic amblyopia. In 88 patients, abnormal stereopsis was found by at least one stereo test. Twenty four of these children had abnormalities in all three stereo tests. Abnormal results were found in 74%, 68% and 62% of the amblyopic children with TNO, Titmus and Randot stereo tests respectively. The sensitivity of various stereo tests for detection of amblyopia was 74% for TNO, 68% for Titmus and 62% for Randot tests (Table 3). Of 44 patients with anisometropic amblyopia, 34 showed abnormality by at least one stereo test (30 patients with TNO, 28 patients with Titmus and 25 patients with Randot test). Of 56 patients with strabismic amblyopia, 51 showed abnormality by at least one stereo test (46 patients with TNO, 42 patients with Titmus and 39 patients with Randot test).

In the screening situation, the sensitivity of various tests was 55.5% for TNO, 48.4% for Titmus, and 44.4% for Randot. In clinical situation, the respective frequencies were 74%, 68% and 62%. All stereo tests had better sensitivities in clinical situation ($p<0.05$).

Discussion

In recent years much emphasis has been placed on the use of stereo acuity testing as a screening method to detect anomalies of binocular function. Studies on the screening qualities of stereo tests had disparate results. Some studies have shown low sensitivity of stereo tests (TNO, Titmus, and Randot) in screening situation, while several authors have concluded that Titmus, Randot and TNO stereo tests are insufficient for screening purpose.[2,10-12] Other studies suggested that stereo tests are fast and reliable methods of screening for amblyopia and strabismus in children.[3-9]

We used three stereo tests (TNO, Titmus and Randot) for screening of amblyopia. These tests had different sensitivities. The sensitivity of TNO test was highest (55.5%) and that of Randot test was the lowest (44.4%), although the differences were not statistically significant. The results of present study were consistent with those of Ohlsson *et al*., who reported the sensitivities of various stereo tests for detection of amblyopia as 36% for Randot E, 38% for Titmus, and 46% for TNO.[2] Other studies showed that TNO test was a suitable screening test for amblyopia in children.[5,8,9] TNO test was also found to be more reliable than Titmus test for detection of amblyopia in children.[3]

The age was indicated to be an important factor that might influence the results. In our study no significant difference was found between the mean of stereo acuity in two age groups in regard to 3 stereo tests. Children in our study were older than those of previous studies[3,5,7-12] which may have affected the results. It is unclear whether there was a differ-

Table 3: Abnormal stereo tests in 100 Amblyopic children in clinical situation

Abnormal test	Strabismic amblyopia	Anisonetropic amblyopia	All amblyopia
TNO	46 (82%)	30 (68.1%)	74 (74%)
Titmus	42 (75%)	28 (63.1%)	68 (68%)
Randot	39 (69.9%)	25 (56.8%)	62 (62%)

ence in stereo acuity between preschool and older children.[2] Heron *et al*. found that performances in relation to Randot and TNO tests were adult-like in 7-year old children, a finding contrary to the results of Titmus test for the same age.[14] Stereo acuity with TNO test improved by a factor of two over the age interval 4-12 years and reached adult-like level between the ages of 4 and 5.5 years.[8] Such improvement was not observed for Titmus test.[3]

The circumstances of the testing situation also influenced the outcomes. In our study the sensitivity of the tests in the clinical setting were higher than those of the screening situation. The screening examination was performed during school hours, which might have led to low concentration in relation to clinical situation. Hope and Maslin found considerable differences in performance between the results of Random-dot stereo test in a clinical and those of screening situations. In contrast to the findings of screening situation, the results obtained in the clinic were reliable.[15] This was in agreement with our results according to testing situation. It has also found that stereo acuity was dependent on concentration and interest.[16] This may account for a more favorable result obtained from clinical situation.

The sensitivity of stereo tests was higher for detection of strabismic amblyopia than anisometropic amblyopia. Ohlsson *et al* also showed that sensitivities of stereo tests for detection of strabismus were higher than amblyopia.[2]

Another factor that might have influenced the results of the present study was performing large number of tests for children on the same day. The children might perform unfavorably in this situation due to exhaustion effect comparing to a situation in which only one or a few of the same tests were done.

The number of over-referrals and under-referrals were dependent on the pass-fail criteria adopted. Balance between the sensitivity and the rate of over referrals was important for confirmation of a screening test. As Simones correctly argues, a lower pass-fail criterion was likely to lower the number of under referrals and would probably increase the percentage of over referrals.[17]

Using 240 second of arc, 100 second of arc and 70 second of arc as cutoff values for TNO, Titmus and Randot tests, Ohlsson *et al*. stated that these tests were not qualified for screening situations.[2] Employing the same stereo tests and cutoff values, we concluded that none of these tests was suitable for screening amblyopia or strabismus in children. Although these tests might offer a system for testing both optical and motor components of vision, and administered by non-ophthalmologist, there is no way to separate normal and abnormal responses. However, combination of stereo tests with visual acuity testing may decrease the percentage of over referrals.

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