Brückner Test Sensitivity to Detect Foveal Dimming

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ABSTRACT

Objectives: To assess the sensitivity of the Brückner test in detecting a change in the brightness of the fundus reflex (Brückner reflex) when the fixation point changes between the ophthalmoscope light and a visual target beside the ophthalmoscope.

Methods: In a prospective, single blinded, randomized study, 3 experienced examiners conducted the Brückner test on 10 subjects with central fixation, normal visual acuity (≥ 1.0), and absence of any organic eye disorder. The test was performed at a distance of 1 m with and without pupillary dilatation, allocating 4 different degrees of ocular deviation (2.5 deg, 5 deg, 7.5 deg, 10 deg) on either side of the ophthalmoscope. The lateral fixation targets were marked by bold crosses. The subjects were asked to close one eye and to change fixation between the light of the ophthalmoscope and one of the 8 crosses starting either at the light or at one of the eccentric targets. The sequence of targets was unpredictable for the examiner and followed a previously prepared chart on which the targets were called A or B in a pseudo-random order. In each trial, the examiner had to state in which position, either A or B, the Brückner reflex appeared brighter, this when the subject was fixating the light or the eccentric target (or vice versa). Subjects were divided into 2 groups, 5 emmetropes aged 17-24 years (mean 21 years), and 5 myopes (0.25-2.50 diopters) aged 21-25 years (mean 23.6 years).

Results: With non-dilated pupils, in 97.2% of 160 trials on emmetropes (OD, 96.2%; OS, 98.1%) and 97.5% of 160 trials on myopes (OD, 96.9%; OS, 98.1%), the red reflex appeared brighter when the subject fixated the eccentric target. With dilated pupils, corresponding rates were 97.2% (OD, 95.1%; OS, 99.3%) in 144 trials on emmetropes and 99.7% (OD, 99.4%; OS, 100%) in 160 trials on myopes, regardless of horizontal direction and degree of eccentricity.

Conclusion: In eyes without organic pathology, the Brückner test allows for sensitive discrimination between alternate central fixation of the ophthalmoscope light and fixation of a target beside the light.

Key words: Amblyopia; Brückner reflex; Brückner test; Strabismus

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Introduction

The idea of performing a test which allows detection of strabismus and other amblyogenic risk factors by means of the fundus red reflex came from the German and French[(1)] literature through an article published in 1962 by Roland Brückner, who was an ophthalmologist working in Basel, Switzerland, at that time. Brückner illuminated both pupils from a distance of 1 m and assessed the following criteria [Brückner 1962]:[(2)]

1. Position of the 1st Purkinje images relative to the pupil

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2. Colour of the fundus red reflex in the pupil
3. Size and constriction of the pupils
4. Eye movements with alternating illumination of the pupil

Assessment of the first two criteria requires simultaneous illumination of both eyes, while assessment of the following two criteria requires alternate illumination of both eyes. Comparison of the positions of the 1st Purkinje images in both eyes had already been described by Hirschberg as a method to estimate the amount of manifest strabismus. Hirschberg assumed that asymmetry of 1 mm in the 1st Purkinje images of both eyes corresponded to a squint angle of 7 degrees.[(3)] Later it has been shown that factually 1mm corresponds to an angle of 12 degrees.[(3,4)] Therefore and due to possible difference in the angle kappa between both eyes, the use of the Hirschberg method to detect small angle strabismus is limited. In 1965, Brückner stressed the essential component of his test which is the assessment of the red reflex of the fundus when the pupil is lighted and viewed through a direct ophthalmoscope.[(5)] He described inter-ocular difference in brightness of the red reflex in manifest strabismus with the brighter reflex coming from the deviated eye when the patient was fixating the ophthalmoscope light. This component was new regarding strabismus diagnosis.

Amblyopia is estimated to affect approximately 2-5% of the population in the Western countries, and is the leading cause of vision loss in children and adults. It is considered a significant preventable cause of vision loss. Causes of amblyopia include ptosis, media opacities, strabismus, and refractive errors.[(6-9)] Early detection of these factors plays a role in preventing or minimizing the deepening of amblyopia. Reliance on the subjective response and cooperation of the child being examined is the limiting factor in performing screening tests to detect amblyopia.[(1,6,8)] Brückner test can overcome such obstacles.

The Brückner test is performed with a direct ophthalmoscope. While the light beam is directed into the patient's eyes simultaneously, the reflected light coming from the pupillary zone should be observed and evaluated in terms of glowing bright red reflex or dim red reflex. Dimming occurs in the fixating eye when the patient takes up central fixation of the ophthalmoscope light. One of the major factors explaining the dimming phenomenon is the pupillary light reflex. Central fixation of the ophthalmoscope light causes pupillary constriction due to the higher light sensitivity of the fovea compared to the paracentral or peripheral retina. So the pupils become smaller when the patient looks directly into the ophthalmoscope light. This leads to both less illumination of the retina and less amount of light coming back through the small pupil to the examiner's eye. Since direct and consensual pupillary light reflexes are nearly equal, detection of strabismus by means of inter-ocular asymmetry in the fundus red reflex, i.e., by lack of foveal dimming in the deviated eye, cannot be explained by pupillary constriction.[(1,2,5,6,10)] So, if strabismus shall be detected by asymmetry in the fundus reflex of both eyes not due to anisometropia, differences in reflectivity of the central vs. paracentral retina or retinal surface, respectively, must be the decisive factor (Fig. 1). As a precondition to detect strabismus by inter-ocular difference in the fundus red reflex, the test must allow for reliable discrimination between the red reflexes of the central and the eccentric fundus.

This study was conducted to investigate the capability to discriminate between central monocular fixation of the ophthalmoscope light and of a target beside the light when the gaze was alternating between both targets.

Methods

This single blinded study was conducted in the Department of Ophthalmology, Justus- Liebig-University of Giessen. Examiners were two ophthalmologists and one medical student in his 6th year of medical education. A scale was prepared in the form of a cartoon bar which was fixed horizontally on the front side of the ophthalmoscope head (Beta 200, Heine Optotechnik, Herrsching, Germany). On this bar, four fixation targets on either side of the ophthalmoscope were drawn. Their position was calculated by using the tangent function. In centimeters, this were 100 tan α, for α = 2.5 degrees, 5.0 degrees, 7.5 degrees, and 10 degrees. Targets were marked as red and black bold crosses, alternating in color, to make communication and fixation easier.

First the experiment was explained to the participants who were medical students and trainee orthoptists (in the following called subjects). Written informed consent was obtained from all

Fig. 1. Spectralis (Heidelberg Engineering HRA+OCT Spectralis) image of the central fundus of a normal eye. Part of the light shining onto the fovea is not reflected back to the pupil due to the inclination of the foveal clivus

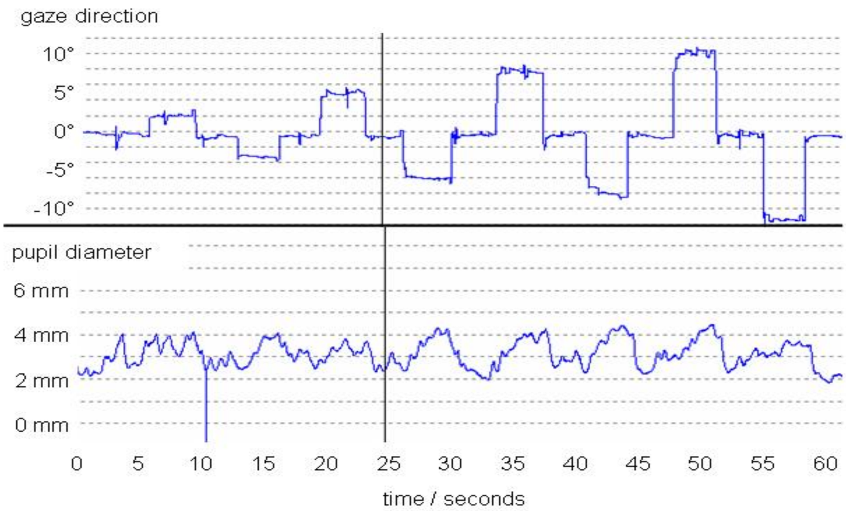

Fig. II. Video-oculography of pupillary light reflex when gaze alters between the ophthalmoscope light and targets of various horizontal eccentricities beside the ophthalmoscope light

subjects adhering to the tenets of the Declaration of Helsinki. All subjects underwent autorefractometry (Topcon RM-8800), visual acuity determination (according to EN ISO 8596), slit lamp examination (Haag Streit M-900) for the anterior and posterior segments using a 78 D biomicroscopy lens (Volk Double Aspheric), stereo testing (Lang 1 random dot stereo test), and orthoptic examination including alternate cover testing at far fixation (5m) of a small light and near fixation (0.3m) of a small recognition target forcing accommodation. Exclusion criteria were any organic eye disease, strabismus, and hypermetropia.

Then the subject received by the investigator a sheet on which for each trial the position of the ophthalmoscope light was defined by the letter A or B and one of the eight visual targets by the opposing letter B or A. Eight such positional orders according to the 8 eccentric target positions were pre-defined in a pseudo-random sequence. The distance between the examiner and the subject was adjusted to 1 m. The room light was switched to dim mood and the subject was asked to close one eye by his or her hand. The investigator who stood behind the examiner let the subject move gaze between A and B, according to the scheme on the sheet. The examiner looked through the ophthalmoscope and had to decide which position, A or B, gave the brighter red reflex. The decision was recorded by the investigator or by a fourth person. The same procedure was performed on the other eye. In another session, the subjects were examined again, following the same protocol, 10 minutes after installation of 3 drops of tropicamide 1% solution (Mydriaticum Stulln®) within 20 minutes. Pupillary dilatation and complete blockage of the pupillary light reflexes were mandatory. In all stages of testing the test was carried out at least by two of the three examiners.

Results

The 10 subjects were divided into 2 groups. Group 1 included 5 emmetropic female subjects aged 17 to 24 years (mean, 21 years). With non-dilated pupils (Table I), there were 160 trials on each eye, 64 for examiner 1(QA), 80 for examiner 2 (CV) and 16 for examiner 3 (MG). The trials of each examiner were performed for all eccentricities on the examined subject. Finally, there were 8 trials on each eccentricity for QA, 10 for CV, and 2 for MG. Examination on right eye (OD) yielded the brighter reflex from the nasal fundus (i.e., when the subject was fixating a target on the left hand side of the ophthalmoscope light compared to fixation of the ophthalmoscope light) and the dimmer reflex from the fovea in 18 (2.5 deg), 20 (2-5 deg), 20 (7.5 deg), and 20 (10 deg) of 20 trials. Comparing fixation of the ophthalmoscope light and a target on the right hand side of the light, the brighter reflex came from the temporal fundus in 19, 20, 18, and 19 of 20 trials, respectively. In left eye (OS), 20, 20, 20, and 19 of 20 trials the brighter reflex came from the nasal and 19, 20, 20, and 19 trials from the temporal fundus. Thus in 97.2% (OD, 96.2%; OS, 98.1%) of trials on emmetropes, the red reflex appeared brighter when the subject was fixating an eccentric target compared to fixation of the ophthalmoscope light, regardless of the horizontal direction and degree of eccentricity of the eccentric target.

With the use of mydriatic eye drops on the same subjects, there were 144 trials (QA, 64; CV, 80). Out of 18 trials on each eccentricity in OD, the reflex from the nasal fundus appeared brighter compared to the central reflex in 17, 18, 18, and 18 trials. The reflex from the temporal fundus was brighter in 17, 18, 15, and 16 trials, respectively. For OS, corresponding rates were 18, 18, 18, and 18 nasally and 17, 18, 18, and 18 temporally. Thus, of 144 trials on mydriatic emmetropes, 97.2% (OD, 95.1%; OS, 99.3%) yielded the brighter red reflex when the subject was fixating an eccentric target compared to fixation of the ophthalmoscope light, regardless of the horizontal direction and degree of eccentricity of the target (Table II). This means, the mean sensitivity of the test to detect central fixation of the ophthalmoscope light was 97.2% both with reactive and with dilated pupils.

Group 2 included 5 subjects aged 21-25 years (mean 23.6 years) who were myopic by -0.25 to -2.50 diopters in OD and -0.25 to -2.00 diopters in OS. Of 160 trials conducted without mydriatic eye drops, 64 were performed by QA, 80 by CV, and 16 by MG with the following results (Table III). In OD, the brighter reflex came from the nasal fundus in 18, 18, 20, and 20 trials and from the temporal fundus in 20, 19, 20, and 20 trials. In OS, the corresponding rates were 20, 20, 20, 20 and 19, 19, 20, 19. Thus, 97.5% (OD, 96.9%; OS, 98.1%) of trials on myopes yielded the brighter red reflex was when the subject was fixating the eccentric target, regardless of its eccentricity.

With mydriatic pupils, corresponding rates were 19, 20, 20, 20 (OD nasal) and 20, 20, 20, 20 (OD temporal) as well as 20, 20, 20, 20 (OS nasal) and 20, 20, 20, 20 (OS temporal). Except 1 trial, the Brückner reflex always (99.6%) appeared brighter with fixation of the eccentric target or from the eccentric fundus, respectively (Table IV). This means, there was no significant difference in test sensitivity to detect central fixation of the ophthalmoscope light between myopic and emmetropic eyes, neither with reactive or with mydriatic pupils.

Discussion

Results of this study show a high sensitivity of the test to detect central fixation of the direct ophthalmoscope light by the Brückner reflex test. When fixation changed back and forth between the ophthalmoscope light and an eccentric target, dimming of the Brückner reflex was detected, regardless of the degree of eccentricity of this visual target. Sensitivity did not decrease when pupils were dilated. Results in emmetropic and myopic eyes were equal at that examination distance.

The dimming phenomenon is a necessary precondition to detect strabismus by means of red reflex asymmetry between eyes. Provided normal

Table I. Results in emmetropic eyes with non-dilated pupils

	Total No. of trials on each eye	Nasal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS	Temporal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS
Examiner 1	64	8/8	8/8	8/8	8/7	7/8	8/8	6/8	8/7
Examiner 2	80	9/10	10/10	10/10	10/10	10/10	10/10	10/10	9/10
Examiner 3	16	1/2	2/2	2/2	2/2	2/1	2/2	2/2	2/2
Total	160	18/20	20/20	20/20	20/19	19/19	20/20	18/20	19/19

Table II. Results in emmetropic eyes with dilated pupils

	Total No. of trials on each eye	Nasal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS	Temporal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS
Examiner 1	64	8/8	8/8	8/8	8/8	7/8	8/8	6/8	8/8
Examiner 2	80	9/10	10/10	10/10	10/10	10/9	10/10	9/10	8/10
Total	144	17/18	18/18	18/18	18/18	17/17	18/18	15/18	16/18

Table III. Results in myopic eyes with non-dilated pupils

	Total No. of trials on each eye	Nasal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS	Temporal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS
Examiner 1	64	7/8	7/8	8/8	8/8	8/8	7/7	8/8	8/7
Examiner 2	80	9/10	9/10	10/10	10/10	10/9	10/10	10/10	10/10
Examiner 3	16	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2
Total	160	18/20	18/20	20/20	20/20	20/19	19/19	20/20	20/19

Table IV. Results in myopic eyes with dilated pupils

	Total No. of trials on each eye	Nasal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS	Temporal vs. central Foveal dimming 2.5° OD/OS	5.0° OD/OS	7.5° OD/OS	10° OD/OS
Examiner 1	64	7/8	8/8	8/8	8/8	8/8	8/8	8/8	8/8
Examiner 2	80	10/10	10/10	10/10	10/10	10/10	10/10	10/10	10/10
Examiner 3	16	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2
Total	160	19/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20

pupillomotor innervation and normal reactivity of both pupils, pupillary light reflexes are equal in both eyes when one eye is illuminated. The light coming out of both eyes should be equal, if there is no difference in fundus reflectivity. Dimming of the Brückner reflex can be caused by pupillary constriction which is stronger when the ophthalmoscope light falls on the fovea because the retinal light sensitivity is maximal in the fovea (Fig. 2). The fact that results both with reactive and dilated pupils were equal shows that pupillary light reflex cannot be the exclusive cause of the dimming phenomenon. As a second possible cause of dimming, Brückner mentioned stronger pigmentation compared to the more peripheral fundus and as a third, light reflection at the retinal surface.[2] Due to the inclination of the foveal clivus, part of the light shining through the pupil onto the fovea will not be reflected back to the pupil (Fig. 1). This may be the most decisive factor explaining foveal dimming and would also explain the frequent lack of the dimming phenomenon in young infants,[11] when their fovea is not yet differentiated to an adequate stage. Archer *et al*.[12] mentioned that neonates and most infants younger than 2 months of age do not show dimming of the fundus reflex with fixation. The lack of dimming may be explained by still lacking differentiation of the foveal pit as described above.

Roe and Guyton[10] described specular reflection of the retina from the internal limiting membrane that changes slope with ocular rotation. If significant amount of light were reflected from the internal limiting membrane of the retina, perhaps the slope of the foveolar pit would reflect enough light away from the pupil. For that the red reflex darkens but does not entirely disappear, as the fundus red reflex is not solely caused by reflection from the choroid and the retinal pigment epithelium.[13]

However, it is a different task to assess the Brückner reflex in the same eye when the patient changes fixation between the ophthalmoscope light and a second target, than to compare the brightness of simultaneous Brückner reflexes in both eyes. The first task does not require any gaze movement of the observer who can concentrate on the same pupil and successive change in its brightness. The latter task requires a gaze movement of the observer from one eye to the other eye of the patient. Alternatively the observer can view the patient's nose to assess brightness of both reflexes. Both methods seem to be less sensitive to detect small difference in brightness.

Griffin *et al.*[14] used a photographic method for Brückner testing and found 80% of ocular deviations could be diagnosed when the degree of deviation was at least 5 prism diopters, but they noticed subject error with their method. Thus, detection of manifest strabismus by interocular difference in the fundus reflex appears to be more difficult than discrimination between successive foveal and peripheral retinal illumination in the same eye.

Conclusion

By using the Brückner test, the dimming phenomenon allows for highly sensitive discrimination of foveal vs. parafoveal retinal illumination when the patient's gaze changes between the ophthalmoscope light and an eccentric visual target. It seems to be easier to detect successive changes in brightness of the same pupil than an equal difference in brightness between both pupils which can be caused by strabismus. Regarding the sensitivity to detect small angle strabismus by means of asymmetry in the fundus red reflex, further investigation will be necessary.

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