BrienHolden Vision Institute

EVALUATION OF EYE MOVEMENTS

AUTHOR

Thomas Salmon: Northeastern State University, USA

PEER REVIEWER

Scott Steinman: Southern California College of Optometry, USA

THIS CHAPTER INCLUDES A REVIEW OF:

- Evaluation of fixation movements
- Clinical Evaluation of Saccades
- Pursuit Testing
- VOR/OKR System
- Clinical Research Environment

EVALUATION OF FIXATION MOVEMENTS

GROSS OBSERVATION	Gross observation is essentially just a descriptive method of evaluation because it is very hard to quantify • Fixation should be tested at distance and near (Remember how convergence helps nystagmus?) • The target used should allow for comfortable accommodation, e.g. a Snellen letter slightly above acuity level. At near, a Snellen letter is held at the midline at 40 cm and for children it is held closer for their shorter working distance. • Testing should be done both monocularly and binocularly. Use complete occlusion to reveal maximum fixation disorder. • Check fixation in the cardinal fields of gaze. Look for over-action or under-action, revealing any muscle disorders. Remember other fixation tests that have a subjective component on the patient's part; e.g. red lens, or the maddox rod test. These are challenging to use on some children. • Observe null points in nystagmus.
EXTERNAL PHOTOGRAPHY	• New digital cameras allow for video and still photographs to be taken of eyes. These can be used to educate the patient and family on any abnormalities.

SLIT LAMP OBSERVATION OR VIDEO RECORDING	• Illumination and magnification can be controlled • A fixation light can be used to control gaze • Torsional movement can be observed using a physical landmark such as a vessel or freckle • Fixation abnormality can be observed • The presence of nystagmus or saccadic intrusions can be determined
DIRECT OPHTHAL-MOSCOPY (VISUOSCOPY) AND FUNDUS PHOTOGRAPHY	• Should be done monocularly by occluding the non-fixating eye. • View using the ophthalmoscpe's grid to note fixation • Do not dazzle the macula as this might create abnormal fixation, keep illumination low • Try to do a non-dilated examination or use neosynephrine to avoid changes in nystagmus level • The foveal reflex will shift in the opposite direction to the eye movement • To calculate your expected acuity use the following formula: MAR (minimum angle of resolution) = EF (PD) +1 1/MAR = VA snellen VA= 1/MAR 20/X= 1/ EF +1, so if the EF is 2PD (EF+1 = 2 +1 = 3 = 60/20); the expected VA is 20/60 Where EF = eccentric fixation in prism dioptres; MAR = minimum angle of resolution; Expect the acuity loss to be close to this calculated value, if not, pathology could be present.
KERATOMETRY	Observe the mires, remembering that the eyes move in the opposite direction of what is seen.

CLINICAL EVALUATION OF SACCADES

This method is very difficult to do by simple observation. Consider the developmental ability of the patient when evaluating results.

GROSS OBSERVATION	• Two fixation targets are used and held equidistant from the patient's midline at 40cm. If desired, move the targets closer to allow for observation of smaller saccades. • Vary the timing of the saccadic response to prevent prediction (unless you want to test for prediction in Parkinson's). • Position the targets so that you can observe horizontal, vertical and oblique saccades both monocularly and binocularly. • May be assessed using clear Plexiglas with numbers or letters. • Look for errors in dysmetria, latency and velocity. If there is no neurological cause found, use an Oculomotor test to evaluate the pursuits and saccades.

AUXILIARY TESTS	The King-Devick and Pierce Test are tests that require the patient to name a sequence of digits arranged in various levels of complexity. The patient reads the numbers aloud from left to right and from line to line. Results are scored with respect to the total testing time and error. The King-Devick has more comparative data and a greater difficulty range. If the patient has trouble naming the numbers, this can affect the results. The Developmental Eye Movement Test (DEM) assesses the patient's ability to read numbers aloud, and then assesses the saccade. These tests do not assess the eye movement components such as latency, accuracy and dysmetria but assesses the saccadic tracking performance in complex tracking. The tasks in these tests demand identification.

PURSUIT TESTING

GROSS OBSERVATION	• Remember that saccades take over when the pursuit system is faulty. • Select target velocity and movement. • Begin at 40 cm with the target at the midline and alternate cycles in each meridian. Moving about 6 cm each way, at a speed of about 2 seconds a cycle. • Test 3 to 5 cycles in each meridian. • Test slowly; going too fast will induce saccades. • Watch for smoothness. Note the scoring test from SCCO

VOR/OKN SYSTEM

GAZE STABILITY DURING FIXATION	• Vestibular nystagmus increases in the absence of a fixation target. • Note nystagmus with fixation and have the patient close his eyes so you can observe the cycle through the eyelids. An increase in nystagmus indicates a vestibular problem. • Blur the vision with a pair of high magnifying lenses. Blurred vision should increase the nystagmus and magnification with these lenses helps the clinician view the motion.
HEAD ROTATION DURING FIXATION	• Patient fixates binocularly on a visual acuity chart; the head is rotated horizontally and vertically. Note the ability to hold fixation as the head is rotated. • A direct ophthalmoscope also allows head rotation to be monitored during fixation. The optic nerve head is observed as the head rotates.
OPTOKINETIC DRUM OR TAPE	• The patient views the repetitively moving target at a moderate speed. • Allow 30 seconds for the response to build • The OKN response will be present in hysterical blindness but absent in blindness • An OKN response indicates approximately 20/200 vision. • The Optokinetic drum assesses the OKN and pursuit systems in young and non-verbal patients • It may invert a congenital nystagmus

CLINICAL RESEARCH ENVIRONMENT

ELECTRO-OCULOGRAPHY: EOG	Direct Current Electro-oculography uses the electronic difference between the cornea and the retina to measure movement by measuring changes in the electric field potential. Electrodes are attached at the horizontal temporal region and with a common nasal electrode attached above the nose. A ground wire is placed above the earlobe. If the movement is not conjugate, electrodes are placed nasally and temporally for each eye. **Advantages:** • It can measure up to +/-70 degrees of movement. This is of benefit when muscles work to their limits in order to maximize the defects shown by paresis. • Easy to set up • Can assess both horizontal and vertical eye movements • Does not require bulky, obstructive instrumentation attached to the head • Spectacles can be worn if needed **Disadvantages:** • There may be interference by other electrical signals, which are stimulated by blinking or facial muscles • System resolution is no better than 1 degree, so some jerk nystagmus and saccadic intrusions may not be seen. • The signal is influenced by changes in light adaptation that occurs either during step changes in overall ambient room or test field illumination or by occluding an eye. Skin should be clean. Field and test illumination should be constant for 10 minutes in order to stabilize the retinal activity. The patient needs to be comfortable so as to prevent unwanted signals from head and neck muscles
INFRARED LIMBAL REFLECTION	• Other names for this technique include photocell, photodiode, photoelectric, scleral reflection and limbal tracking system • A low wattage infrared source illuminates the exposed surface of the eye. Sensors aimed at these areas pick up differences in reflected light, which creates a signal. • Resolution is 0.25 degrees • Can be used to +/- 20 degrees of gaze • Eyelid signals may interfere with vertical movement recordings • Many models are available such as the Eye Track and the Visagraph
ELECTRO -MAGNETIC SEARCH COIL	• Fine wire coils are embedded in a soft annular contact lens worn by the patient which measure voltage changes related to the horizontal, vertical and cyclorotary eye positions. • Low noise and high resolution • Poor comfort.

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