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Chapter 4: Assessment of Study Measures

4.1 Overview

4.1.1 Overview of Eligibility and Masked Examination Procedures

The following measurements will be taken at all eligibility examinations and at all masked examinations. The order of testing for these examinations will be:

1. CISS
2. Cover testing (distance and near)
3. NFV at near
4. PFV at near
5. NPC
6. Accommodative amplitude (RE only)
7. Accommodative facility (RE only)
8. CISS

The subject must wear his/her optical correction for each of the above tests. If the subject does not bring his/her optical correction to the visit, a trial frame should be prepared which contains the subject's correction.

The neurological checklist, academic performance questionnaire, eligibility medication form, personal history form, contact information form, and eligibility checklist must also be completed at the eligibility examination. Completion of the consent for use of information and persona form is **not** required for participation, but must be completed before a patient's image can be included on any CITT bulletin board, etc.

Other test results that must be collected at eligibility examinations include corrected visual acuity (distance and near), versions, stereopsis, pupil testing, cycloplegic refraction, and eye health (anterior and posterior segment examination). All tests except the posterior segment examination must be performed either at or within 2 months prior to the initial eligibility examination. A posterior segment examination must be performed either at or within 12 months prior to the initial eligibility examination.

Corrected visual acuity must be tested prior to performing the masked examination at the 12 week, 6 month, and 12 month masked examinations. If corrected visual acuity is 20/30 or worse in either eye with the current correction, a subjective refraction should be performed (to achieve 20/25 or better vision) and testing should be performed with the best correction in a trial frame.

The medication form must be re-administered at all masked examinations. The academic performance questionnaire must be repeated at the 12 week, 6 month, and 12 month masked examinations. The same parent/guardian who completed the academic performance questionnaire initially must again complete the form at subsequent visits. (If a different person brings the child to these examinations, the academic performance questionnaire can be sent home and then the completed form can be returned via mail or the results can be obtained over the phone.)

4.1.2 Equipment Needed for Masked Examination Procedures

1. B-16 prism bar (1, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 25, 30, 35, 40, and 45 prism diopter prisms)
2. Astron International (ACR/21) Accommodative Rule (Gulden 15150 Near Point Rule)
3. Gulden Fixation Stick #15302 with 40 cm. CITT string attached to fixation stick
4. Printed Gulden Fixation target (with single column of 20/30 letters) for the Accommodative Rule
5. ± 2.00 D flipper lenses
6. Stopwatch

4.2 Primary and Secondary Outcome Measures

4.2.1 Convergence Insufficiency Symptom Survey (CISS)

This is the first test that is administered. After all primary and secondary outcome measures, and monocular accommodative testing measures are taken (i.e., Eligibility Form-Part 2 or Masked Examiner Form is completed), the CISS is repeated.

Testing Protocol

1. The Convergence Insufficiency Symptom Survey should be administered first before any other testing is administered. It is then repeated after all other testing is completed.
2. Before administering the CISS, the subject is given a card to hold which contains a list of the five response options (i.e., Never, Infrequently (not very often), Sometimes, Fairly Often, and Always).
3. Before reading the questions the investigator should say the following to the subject: "Please answer the following questions about how your eyes feel when reading or doing close work. First think about whether or not you have the symptom. If you do, please tell me whether the problem occurs: Infrequently (not very often), Sometimes, Fairly Often, or Always."
4. Each question should be read verbatim, slowly, and clearly.
5. If subject responds with "yes" – the investigator should ask the subject to qualify the frequency by choosing one of the following five options: "Never, Infrequently (not very often), Sometimes, Fairly Often, or Always".
6. The investigator should **never** give examples regarding any of the questions or response options. However, he/she may repeat the question and ask the subject to answer as best as he/she can.
7. The investigator will record the response to each question on the CI Symptom Survey form.

4.2.2 Near Point of Convergence (NPC)

Testing Protocol

1. Make sure ambient and overhead lighting provide good illumination.
2. Begin testing with subject wearing his/her optical Rx.
3. Use the Astron International (ACR/21) Accommodative Rule with the printed Gulden fixation target consisting of a single column of 20/30 letters at 40 cm.

4. Hold the edge of rule on the center of the subject's forehead just above the level of his/her brow (so the patient is looking down slightly at the target). Begin with the target placed at the 40 cm mark on the rule.
5. Instruct subject "to look at letters and report when they become double or break into two but try to keep the target one/single as long as possible."
6. Slowly (1-2cm/sec) move target toward subject. When diplopia is reported stop moving the target and ask the subject "Does it stay two or does it come back into one?"
 - If it comes back into one within 1-2 seconds, continue slowly moving the target towards the patient until the patient is unable to regain fusion. Do not hold the target in place for longer than 2 seconds.
 - If it stays double, this endpoint is the NPC break.
 - If the examiner observes a loss of fusion (without a report of double), the point at which the examiner observed a loss of fusion is considered the NPC break.
 - If the patient continues to converge until the target is against the nose/brow (i.e. break does not occur), measure how closely the subject converged and consider this the NPC break.
7. Measure the NPC break to the nearest half centimeter (using the center of the subject's forehead just above the level of the brow as the zero measure point from which the NPC is taken.)
8. If the subject did not break, have the patient close or cover one eye for 3-5 seconds to break fusion so that recovery can be measured.
9. Ask the subject to tell you "when it comes back together into one" and slowly move the target away from the subject until the subject reports single vision or the examiner observes a recovery of fusion. This is the NPC recovery.
10. Measure the NPC recovery to the nearest half centimeter.
11. Record the NPC break and recovery values on the appropriate data form.
12. Measure the break and recovery as described above three times, waiting 10 seconds between paired break/recovery measurements.

4.2.3 Positive Fusional Vergence (PFV) at Near

PFV should be performed after the negative fusional vergence (NFV) assessment (described below 4.3.8). The examiner should wait 30 seconds after the NFV measure before performing the PFV measures.

Testing Protocol

1. Make sure ambient and overhead lighting provide good illumination.
2. Ensure that prisms are clean and that there are no scratches that may interfere with the patient's ability to see the target.
3. Begin testing with subject wearing his/her optical Rx.
4. Place target (Gulden Fixation Stick with single column of 20/30 letters) in primary gaze 40 cm from subject's eyes. (Check testing distance with CITT string attached to fixation stick.)
5. Place Gulden B-16 horizontal prism bar with the flat side of the prism bar towards the subject in a base-out orientation with subject viewing through 1Δ BO.

6. Ask subject to “tell me when the letters become blurred or become double (split into 2), but try to keep the target single as long as possible” as BO prism is introduced.
7. Increase magnitude of BO prism at approx $2\Delta/\text{sec}$, pausing at each prism to confirm that the target is “single and clear.”
8. If the subject reports blur, pause and note BO prism amount then continue to increase BO prism pausing at each prism to confirm that the target is “single.” When the subject reports double or break, ask subject “Does it stay two or does it come back into one?” Continue to introduce BO prism if subject recovers single vision. When subject can no longer maintain single vision and has diplopia, note the BO prism amount and record this value as the “BO break.”
9. After the subject reports diplopia, increase the BO prism by 5Δ , and then at a rate of about $2\Delta/\text{second}$, reduce the BO prism until the subject reports single vision. Consider this the “recovery” finding. If recovery finding is higher than the break, the examiner should repeat the entire measurement (blur, break and recovery).
10. Accurately record blur, break and recovery findings in the appropriate places on the CITT data collection form.
11. If blur is not reported, record “X” on the data sheet (do not leave it blank).
12. Repeat blur/break/recovery sequence 2 more times waiting 30 seconds between measures.

NOTE: If diplopia is not reported but examiner notes loss of fusion, the prism through which fusion is lost will be recorded as the “break” finding. Likewise, an examiner observation or recovery of fusion will be recorded as “recovery.”

NOTE: If the patient is able to fuse the largest (45Δ) prism, record 50Δ for the break value and have the patient close or cover one eye to break fusion so that recovery can be measured. Record the amount of prism through which the patient was able to regain fusion (maximum value would be 45Δ).

4.3 Other Clinical Testing (not Outcome Measures)

4.3.1 Corrected Visual Acuity (Distance and Near)

Note: For determination of corrected distance and near visual acuity, investigators can use the standard acuity chart that they typically use in clinical practice provided that it is age appropriate and uses letter optotypes (e.g., Snellen, ETDRS, Bailey Lovie).

Testing Protocol

1. Make sure patient is wearing his/her optical correction. (A trial frame should be prepared if the subject did not bring his/her optical correction.)
2. With the left eye covered, the examiner will ask the subject to read the first letter on each line until he/she makes an error.
3. When the subject makes an error, the examiner will move two lines higher and ask the subject to call out all of the letters in that row.

- a. If the subject misses more than half of the letters at this acuity level, ask the subject to read progressively larger acuity levels until the subject is able to correctly identify at least half of the letters on a line.
- b. If the subject correctly identifies at least half of the letters correctly at this acuity level, proceed to progressively smaller acuity levels.
4. Stop testing when the subject misses more than 50% of the letters on a line (e.g., 3 out of 5 on a line).
5. The final acuity will be the smallest acuity level at which the subject can identify 50% or more of the letters..
6. Repeat steps 2-5 with the right eye covered.
7. If corrected visual acuity is 20/30 or worse in either eye, a subjective refraction should be performed and visual acuity testing should be repeated with the best correction in a trial frame.

Note: Every few letters throughout the testing encourage the subject and give reminders for the subject to look carefully when reading the chart.

4.3.2 Cycloplegic Refraction

Testing Protocol

1. Administer two drops of cyclopentolate. (Prior administration of topical anesthetic is up to investigator discretion).
2. Perform static retinoscopy 20-30 minutes after instillation of the last drop of cyclopentolate.
3. Perform a subjective refraction.
4. Determine the final cycloplegic Rx using the subjective finding.

4.3.3 Versions

Testing Protocol

1. The subject, with spectacle frames removed, is seated at arm's length from the examiner.
2. The examiner holds a penlight, transilluminator, or other small target in one hand, leaving the other hand free to elevate the lids.
3. The target is held about 30 cm from the eyes.
4. Beginning in primary gaze, the target is moved smoothly to the examiner's right until the eyes are no longer able to follow.
5. The target is then moved upward until the eyes cannot follow, and then downward. On down gaze, the examiner must gently place the thumb of the free hand near the lash line of one lid and the forefinger near the other and lift the lids to allow observation of the iris margins. This is also done on the lower lids for observation of down right and down left.
6. Return the target to the extreme horizontal position and move it smoothly across the midline to the opposite horizontal extreme.
7. Repeat up and down to that side.

4.3.4 Stereopsis (Randot Stereotest)

Testing Protocol

1. Use normal room illumination with auxiliary lighting that does not produce glare on the test booklet, place the polarizing filters on the subject (over best correction with spectacles or contact lenses, if worn), and use a testing distance of approximately 40 cm.
2. Show the subject the symbols on the cover of the book and ask him/her to name them aloud.
3. Direct the subject's attention to the top 4 panels on the right-hand side of the open test book. Ask for each of the 3 panels which contain a shape or figure, "which of the shapes or figures that you just saw on the front of the book do you see here?"
4. Record whether or not the subject achieved 500" of random dot stereo. The subject must identify all 3 of the shapes correctly to have 500" of stereopsis.

4.3.5 Cover Testing: Unilateral (UCT) and Alternate Cover Test (ACT)

Testing Protocol

1. Select an isolated letter 20/30 at 6m.
2. Perform testing through subject's optical correction.
3. Use either the Gulden B-16 prism bar or a comparable loose prism set (i.e., at a minimum the prism set must contain all prisms contained on the B-16 prism bar). Ensure that prisms are clean and that there are no scratches that may interfere with the patient's ability to see the target.
4. Instruct the subject to fixate the letter and to "keep it clear" throughout testing.
5. Cover the subject's right eye (OD) and watch left eye (OS) as OD is covered.
6. Cover the subject's OS and watch OD as OS is covered.
7. Perform the UCT a sufficient number of times to determine if strabismus is present.
8. Allow the subject adequate time to regain fixation.
9. Record the presence or absence of strabismus.
 - a. If a strabismus is present, record whether it is intermittent or constant.
10. Neutralize the ACT according to the following procedure:
 - a. Introduce prism with the base in the appropriate direction.
 - b. Cover one eye with the occluder, interposing the prism behind the occluder.
 - c. Switch the occluder and observe the eye movement behind the prism. (Only observe eye behind prism during ACT.)
 - d. Interpose different magnitudes of prism until neutrality is obtained.
 - e. Continue adding prism until the first reversal (subject was initially exo and now becomes eso through the prism). The amount of prism that resulted in neutrality before this reversal of movement is recorded as the high neutral value.
11. Record the amount and base of prism for the high neutral.
12. Repeat the procedure at 40 cm using a single 20/30 letter. (Check testing distance with CITT string attached to fixation stick.)
13. During the cover test procedure the examiner should also observe whether a vertical deviation is present.
 - a. If a vertical deviation is present, the examiner should measure the magnitude of the deviation and record.

4.3.6 Monocular Amplitude of Accommodation (Right Eye Only)

Testing Protocol

1. Make sure ambient and overhead lighting provide good illumination.
2. Begin testing with the subject wearing his/her optical Rx.
3. Occlude the subject's left eye.
4. Hold the Astron Accommodative Rule (with the printed Gulden fixation target consisting of a column of 20/30 letters at 40 cm) gently with edge of rule above subject's right eye just above the level of his/her brow. Begin with the target placed at the 40 cm mark on the rule.
5. Instruct the subject to, "Tell me when the letters first start to blur, but try to keep the letters clear as long as possible."
6. Slowly move the target toward the subject at approximately 1 to 2 cm/sec until subject reports first blur. Ask if the letters stay blurry or become clear. If target becomes clear, continue moving target closer until blurred. Stop at "first sustained blur."
7. End the test when "first sustained blur" is reported.
8. Measure to the nearest one-half centimeter (using forehead just above the level of the subject's brow as the zero measure point).
9. Record accommodative amplitude in the appropriate spaces on the data collection form.

4.3.7 Monocular Accommodative Facility (Right Eye Only)

Testing Protocol

1. Make sure ambient and overhead lighting provided good illumination.
2. Ensure that the ± 2.00 lens flippers are clean and that there are no scratches that may interfere with the patient's ability to see the target.
3. Perform testing with subject wearing his/her optical Rx.
4. Occlude the subject's left eye.
5. Have subject view the single column of 20/30 letters on Gulden Fixation Stick at 40 cm distance. (Check testing distance with CITT string attached to fixation stick.)
6. Place plus side of ± 2.00 lens flipper before subject's right eye. Ask subject to try to make letters clear as quickly as possible.
7. Instruct subject to report clarity (say "clear") as soon as the letters are clear.
8. When letters are reported to be clear, quickly flip the flipper to the minus side, again instructing subject to read letters & report when clear.
9. Prepare to begin timing for one minute using a stopwatch.
10. Start timing as you place the plus side of the flipper lens in front of the subject's eye. Continue to alternate sides of flipper lenses for 1 minute, while counting the number of "flips" of the lens that the subject was able to clear.
11. Record number of lens flips on data collection form.

NOTE: Even if the subject has difficulty (i.e., is slow or takes awhile) clearing a lens, testing should be continued for a full minute. However, if the subject cannot clear one side of the flipper lens in one minute, then 0 flips will be recorded.

NOTE: The lenses should be “flipped” from one side to another, not slid/moved up and down in front of the subject’s eye.

4.3.8 Negative Fusional Vergence (NFV) at Near

Testing Protocol

1. Make sure ambient and overhead lighting provide good illumination.
2. Ensure that prisms are clean and that there are no scratches that may interfere with the patient’s ability to see the target.
3. Begin testing with subject wearing his/her optical Rx.
4. Place target (Gulden Fixation Stick with single column of 20/30 letters) in primary gaze 40 cm from subject’s eyes. (Check testing distance with CITT string attached to fixation stick.)
5. Place Gulden B-16 horizontal prism bar with the flat side of the prism bar towards the subject in a base-in orientation with subject viewing through 1 Δ BI.
6. Ask the subject to “tell me when the letters become blurred or become double (split into 2), but try to keep the target single as long as possible” as BI prism is introduced.
7. Increase magnitude of BI prism at approx 2 Δ /sec, pausing at each prism to confirm that the target is “single and clear.”
8. If the subject reports blur, pause and note BI prism amount then continue to increase BI prism pausing at each prism to confirm that the target is “single.” When the subject reports double or break, ask subject “Does it stay two or does it come back into one?” Continue to introduce BI prism if subject recovers single vision. When subject can no longer maintain single vision and has diplopia, note the BI prism amount and record this value at the “BI break.”
9. After the subject reports diplopia, increase the BI prism by 5 Δ , and then at a rate of about 2 Δ /second, reduce the BI prism until the subject reports single vision. Consider this the “recovery” finding. If recovery finding is higher than the break, the examiner should repeat the entire measurement (blur, break and recovery).
10. Accurately record blur, break and recovery findings in the appropriate places on the CITT data collection form.
11. If blur is not reported, record “X” on the data sheet (do not leave it blank).

NOTE: If diplopia is not reported but examiner notes loss of fusion, the prism through which fusion is lost will be recorded as the “break” finding. Likewise, an examiner observation or recovery of fusion will be recorded as “recovery.”

NOTE: If the patient is able to fuse the largest (45 Δ) prism, record 50 Δ for the break value and have the patient close or cover one eye to break fusion so that recovery can be measured. Record the amount of prism through which the patient was able to regain fusion (maximum value would be 45 Δ).

4.4 Rule out Systemic/ Neurological Basis for CI

It is important for CITT investigators to carefully examine all potential CITT subjects to rule out a systemic or neurological etiology for the CI. Particular attention should be paid to the case history (onset and duration of symptoms, medical history and medication, accompanying signs/symptoms), pupil evaluation, versions, and evaluation of the retina and optic nerve head.

The CITT Neurological Checklist form serves to ensure uniform collection of historical information across all clinical sites. A positive response on the checklist will render the subject ineligible for the CITT study. The subject must then be referred to an appropriate physician for further evaluation.