

## **A.1. The Neurological Examination**

Students studying Neurological Surgery must adhere to sound principles of clinical medicine. A standard clinical method must be employed with specific evaluation of the history and physical within the context of the nervous system. The symptoms and signs of neurological illness are evaluated by the history and neurological examination, respectively.

### **a. Neurological History**

When obtaining the neurological history, the surgeon must enlist the patient's trust and cooperation and educate the patient as to the importance of the neurological history and examination in the care giving process.

The first step in acquiring the Neurological History of the Present Illness is determining if the patient is a competent historian. The very nature of the neurological disease may render the history indeterminable or limit the reliability of the history obtained. For example, a patient with significant head trauma with diminished level of consciousness may be unable to give a history. In such instances it is necessary for the neurosurgeon to attempt to obtain history from family members, emergency medical personnel, or other witnesses to the event. Indeed, the evaluation of the trauma patient with disturbed level of consciousness includes evaluation of the level of awareness of the patient including the orientation of the patient to present surroundings and person, place and date (the Glasgow Coma Score, which is utilized to rapidly evaluate the level of consciousness in trauma patients, includes three separate categories which records the ability of the patient to respond to the examiner in eye opening, motor examination, and voice, which includes orientation).

A careful documentation of the history is recommended, and the simplest method starts with note taking at the bedside or in the office. Immediate recording of the history ensures maximal reliability. If the accuracy of the history is in question, checking details with an observer or informant is desirable. In addition, careful recording of details enables the examiner to crosscheck the reliability of the history if the patient's history is rambling or circumspect. Errors or inconsistencies in the history may be determined in this manner, as the error may be attributable to the physician or surgeon as well as the patient.

Careful notation of the mode of onset of the illness, evolution, and time course are made. If the patient is unable to offer this information, the friends, family or employer of the patient may contribute important information. Any changes in the symptoms, and circumstances surrounding such events must be recorded. If the patient is unable to supply the details of these events, it may be necessary to judge the course of the illness by what the patient was able to do and perform at various times during the course of the illness (e.g., could he or she walk, how far, activities of daily living, etc.).

### **b. The Neurologic Examination**

The neurological examination has already begun during the interview of the patient for the history of the illness. The nature of the patient's recollection of the events of the history will disclose any alterations in memory or judgment, of difficulty in comprehending or expressing ideas. Careful observation of the patient by the

neurosurgeon will demonstrate any obvious speech difficulties (receptive or expressive), dysarthria, and general motor difficulties. Attention to details and potential inconsistencies of dates or events in the history could suggest some intellectual problems that may be explored further with the neurological examination. The patient's own interpretation of his or her symptoms may expose unnatural anxiety or delusions regarding the illness, indicating some functional overlay on the symptomatology.

The focus and thoroughness of the neurological examination must be tailored to the chief complaint and symptoms manifest by the patient. Furthermore, the examination must be modified by the condition of the patient. A trauma patient with multiple injuries requires a focused and rapid neurological examination to enable the trauma surgeon and the neurosurgeon to prioritize the injuries and proceed with appropriate diagnostic tests and, ultimately, treatment. In a patient seeking relief for back and leg pain associated with nerve root compression, spending extensive time examining higher cerebral function, cerebellar and cranial nerve function may not represent the most economical use of the surgeon's and patient's time.

#### **i. Testing of Higher Cortical Function**

Testing of higher cortical function begins by testing the patient's orientation in time and place, and insight into his/her current medical problem. Routine tests of memory and intellectual function useful at the bedside or office include memory of 3 objects immediately and after 5 minutes, naming of the last 3 presidents, and serial subtraction of 3's and 7's from 100. The patient's recollection of the course of his/her illness, recent events of the day, and course of illness will offer the examiner another avenue to test memory. Such details should be checked with available medical records or with family as appropriate. These bedside tests, the patient's ability to recall the medical history, and noting the ability and manner in which the patient deals with questions often helps the examiner obtain a picture of the patient's sensorium and intellectual functioning without formal intelligence or neuropsychological testing.

Any speech or language disorder should be evident during the history taking or examination of higher cortical functioning. These disorders should be explored by testing of reading, writing, spelling, ability to execute spoken commands, name objects and solve simple arithmetic problems. Visual-spatial difficulties can be assessed by asking the patient to copy figures, draw a clock, a floor plan of the house or office, or one's country.

#### **ii. Cranial Nerve Examination**

Cranial nerves should be examined in anatomical sequence to ensure complete examination of all nerves. Testing of smell should be performed in each nostril separately, and it should be determined if odors can be discriminated. Soap, coffee, or various spices may be used for this purpose. Careful fundoscopic examination is performed to rule out any evidence of raised intracranial pressure. Inspection of the optic disc will show evidence of flattening or frank papilledema with significantly raised intracranial pressure from a variety of causes, including tumors or hydrocephalus. Visual fields are tested by confrontation, and corrected acuity is

tested in each eye. Any abnormalities are further evaluated by formal tangent screen or computed perimetry testing. Oculomotor function is examined by checking pupillary size bilaterally, and reactivity to light and accommodation. The range of movement, as well as any dysconjugate gaze is noted. Particular attention is paid to limitation of direction of gaze and any diplopia noted by the patient. Facial sensation is then tested with a pin and a wisp of cotton. All 3 divisions of the trigeminal nerve are tested in sequence. In addition, the presence of corneal reflexes is tested, and any asymmetry is noted. Facial movements are tested with the patient speaking, smiling, and frowning. Mild weakness will be noticed upon execution of these maneuvers that may be missed at rest. Hearing is then tested with a 256 Hz tuning fork bilaterally, and any asymmetry is noted. Both Rinne's and Weber's tests are performed and recorded. Information from these studies are used to differentiate sensorineuronal from conductive hearing deficits. Audiograms and special tests of auditory and vestibular function are pursued if the bedside testing indicates any abnormalities of eighth nerve function, or diseases of the cochlear or labyrinthine end organs. Any hoarseness of voice is noted, as this may be an indication of vocal cord dysfunction. Pharyngeal sensation is tested bilaterally with the gag reflex. The position of the uvula at rest is noted, and the elevation of the soft palate and uvula is tested. Separate testing of trapezius and sternocleidomastoid muscle strength is performed. Inspection of the tongue at rest is informative, as atrophy and fasciculations may indicate disease of the lingual nerve. The patient is then asked to move the tongue in each lateral direction, and any weakness is recorded.

### **iii. Motor Function Testing**

The motor examination should involve a close and complete inspection of all muscle groups. It is important to have the limbs fully exposed, and note any evidence of muscle wasting, or fasciculation. The examiner must be attentive to the speed, strength and coordination of the muscle movements. The patient should maintain the arms outstretched in the prone and supine positions, and accomplish simple tasks such as buttoning clothes, opening a safety pin, or picking up simple objects. The strength of the legs may be similarly tested, with the patient supine and the legs flexed at the hips and knees, or prone with the knees bent. An attempt must be made to test muscle function in the position of function if possible. For example, only testing of gastrocnemius and soleus strength while ambulating will help the examiner determine if the patient has any mild loss of function. For this reason, estimates of the strength of leg muscles in bed are highly unreliable. All individual muscle group strength is recorded for the medical record. Testing of the motor system should also include careful observation for any movement disorder, disorder of posture (e.g. Parkinson's disease) or tremor. Simple tests of coordination, such as asking the patient to alternately touch his/her nose and the examiner's finger, or having the patient run a heel down the contralateral shin are useful and should be performed in all cases.

### **iv. Sensory Function Testing**

This is the most time-consuming and difficult part of the neurological examination. Sensory testing must be carried out in all extremities, and with multiple modalities.

A quick survey of all regions with light touch and pin will determine if any gross abnormalities exist which should then be more carefully mapped out. Movement from an area of diminished sensation to one of normal enhances the perception of a difference. The sensory examination should include a conscious testing of modalities subserved by the lateral spinothalamic pathway (pain, temperature), anterior spinothalamic tract (touch/deep pressure) and posterior column-medial lemniscal system (light touch/proprioception/vibration and position sense). Any sensory disturbance must be examined in detail, to enable the examiner to differentiate anatomically the disorder. An understanding of sensory disorders depends on knowledge of functional anatomy.

The sense of touch is usually tested with a wisp of cotton. The examiner will ask the patient to state "yes" when the stimulus is applied to various parts of the body. Cornified areas of the body, such as the soles and the palms will require more of a stimulus to evoke a response. On the contrary, glabrous areas of the skin may be more sensitive to stimulus because of the numerous nerve endings around the hair follicles.

Pain is usually assessed by pinprick or pinwheel. It is almost impossible to consistently apply equal pressure with pin testing. The boundaries of any diminished region of sensation must be delineated carefully. Deep pressure-pain may be tested by pinching or pressing deeply on the tendons or muscles.

Thermal sense may be tested in all extremities. It must be remembered that the perception of thermal stimuli may be delayed, and dependent upon the size of the object used to test the temperature sensation. Glass tubes filled with warm or cold water are useful for testing temperature. Any difference in temperature testing between the proximal or distal extremities is noted, which may indicate peripheral nerve disease.

Perception of passive motion is first tested in the fingers and toes, since any deficit will be first noted in these regions (most sensitive testing). Any evidence of loss of position sense in these regions would then dictate more proximal position sense testing.

Vibration testing is performed by using a low rate and long duration of vibration (128 Hz) over bony prominences. The patient must be attentive to the vibration, and not merely the pressure sensation. Vibration sense and position sense are usually lost together, although vibration sense may be affected disproportionately. Vibration is most commonly diminished at the toes and ankles.

Discriminative sensory functions are tested after completion of the above primary sensory functions. Tests such as two-point discrimination, graphesthesia, and appreciation of texture, size, and shape is dependent upon functional sensory cortex or thalamo-cortical projections. Any disturbance of position sense with intact primary sensory function, or, if a cerebral lesion is suspected on other grounds, would dictate a careful testing of discriminative sensory function.

The anatomic pattern of the sensory loss, such as dermatomal in pattern, a distribution of peripheral nerve, or "stocking and glove" must be noted. Any spinal level of sensory loss is documented. Careful documentation of the laterality of loss

and modalities involved may give indication as to the potential nature of a spinal lesion.

**v. Reflex Function Testing**

In testing tendon reflexes, it is essential that muscle groups be relaxed. Barely elicitable reflexes can be facilitated by voluntary contraction of other muscle groups (Jendrassik maneuver). Testing of the biceps, pectoralis, triceps, supinator, patellar, Achilles, plantar and cutaneous abdominal reflexes comprises adequate testing of the sampling of reflex activity of the spinal cord. Careful elicitation of the plantar response can be evoked by stimulating the sole of the foot along its outer border from heel to the toes. The examiner must be aware that plantar responses may be confounded because of a high level avoidance response, and withdrawal responses may interfere with the interpretation of the Babinski sign.

**vi. Gait/Stance Testing**

Gait and stance testing is usually the final aspect of the examination of the neurological system. An abnormality of gait and stance may be the only neurological abnormality in cases of frontal lobe or cerebellar lesions. Tandem walking may unmask subtle problems with balance not manifest with normal gait testing. Furthermore, disequilibrium with standing with eyes closed may indicate a loss of balance that is secondary to a sensory (posterior column proprioceptive) problem (Romberg test).