Eye movements are rapid (saccades) or slow (smooth pursuit and vestibulo-ocular reflex, VOR), conjugate or discon-jugate (convergence), and organized, at least at the brainstem level, in the horizontal and the vertical planes.

At bedside examination, saccades and fixations in the four cardinal positions of the eyes should be tested first during rapid motion to detect any abnormality in the movement (reduced in amplitude or velocity) and secondly during fixation (if there is nystagmus). When this eye examination is normal, it is not useful to test other movements. If saccades are impaired, examination of the VOR (oculocephalic reflex) and convergence may determine whether impairment involves all types of eye movements, which implies nuclear or infranuclear (nerve or muscle) damage, or only one type of eye movement, which implies supranuclear damage.

The abducens nucleus (VI), at the pontine level, controls all ipsilateral eye movements, with abduction mediated via the abducens rootlets and adduction via the medial longitudinal fasciculus (MLF). Damage to the latter results in internuclear ophthalmoplegia (with adduction paralysis and monocular nystagmus in the contralateral eye), which is the most frequent horizontal eye movement paralysis. In “one-and-a-half” syndrome, both the MLF and the sixth nucleus are damaged on the same side of the pons.

The oculomotor nucleus (III) and trochlear (IV) nucleus, at the midbrain level, control all vertical eye movements and convergence. Third nerve nucleus syndrome comprises an ipsilateral oculomotor paralysis and a contralateral superior rectus paralysis, because of decussation of the superior rectus motoneurons. Bilateral damage to the rostral interstitial nucleus of the MLF (controlling vertical saccades), at the upper midbrain level, results in downward and upward saccade paralysis. Unilateral damage to the posterior commissure, at the postero-superior extremity of the midbrain, results in upward saccade paralysis, which is the most frequent vertical eye movement paralysis.
14.1 Introduction

Eyes can move rapidly or slowly. Rapid eye movements are saccades (voluntary saccades and quick phases of nystagmus) and slow eye movements comprise smooth pursuit, the vestibulo-ocular reflex (VOR) and convergence. Eye movement commands originate in various cerebral hemispheric areas (for saccades, smooth pursuit and convergence) or in labyrinths (for the VOR). They are carried out in the brainstem by the immediate premotor structures and the motor nuclei. Conjugate lateral eye movements are largely organized in the pons, and vertical eye movements and convergence in the midbrain. In the first part of this chapter, we will see the anatomo-physiological organization of eye movements in the brainstem and the main types of eye-movement paralysis resulting from brainstem lesions. Such types of abnormalities are easily detected at the bedside by studying three main types of eye movements, allowing the examiner to determine whether damage is nuclear-infranuclear or supranuclear (Fig. 14.1): saccades, i.e., rapid eye movements made towards a visual target (such as the examiner’s finger); the vestibular ocular reflex (VOR), tested using the oculocephalic movement by passively moving the subject’s head; and convergence, tested using a small object drawing near to the subject’s nose. Smooth pursuit is relatively difficult to interpret and may be omitted at bedside examination. In the second part of this chapter, eye-movement disturbances due to cerebellar and cerebral hemispheric lesions, resulting in relatively more subtle syndromes, will be reviewed briefly. The last part of the chapter deals with some abnormal eye movements.

Summary for the Clinician

- Routine bedside examination of eye movements comprises saccades (voluntary movements) and fixation in the four directions of gaze, and this is sufficient if no abnormality is detected.
- When saccades are abnormal, the VOR (oculocephalic reflex) and/or convergence should be tested to determine the location of damage: nuclear-infranuclear (nerves, extraocular muscles) or supranuclear.