Apart from its importance in the treatment of squint, an adequate knowledge of the movements of the eyes, and their neuromuscular control, is of considerable value in understanding the physiological mechanisms concerned with the maintenance of posture; moreover, it would seem that our perceptions of objects, and particularly of their spatial relationships, are determined in part by the laws governing the movements of the eyes.

The Muscles

The Recti

The muscles concerned with the eye movements are six in number: the medial and lateral recti, which determine sideways movements; the superior and inferior recti causing primarily upward and downward movements, and the superior and inferior obliques, which, when acting alone, primarily cause the eye to twist around its antero-posterior axis.

The insertions of the rectus muscles are indicated in Fig. 24.1, and since the muscles arise from a common origin at the apex of the orbit, their main actions of elevation, depression, adduction (i.e. pulling towards the nose) and abduction, are not difficult to appreciate.

The Obliques

The superior oblique (Fig. 24.2) likewise arises from the apex of the orbit but after running above the medial rectus almost to the orbital margin, it becomes tendinous as it passes through a cartilaginous pulley, the trochlea, and turning sharply backward, downwards, and laterally over the eye it is inserted into the postero-lateral aspect of

Fig. 24.1 Insertions of the rectus muscles. The medial rectus is to the right of the diagram. (Duke-Elder, Textbook of Ophthalmology.)

Fig. 24.2 Extrinsic muscles of the eye from above. 1, superior rectus; 2, levator palpebrae superioris; 3, medial rectus; 4, lateral rectus; 5, superior oblique; 6, reflected tendon of the superior oblique; 7, annulus of Zinn; 8, optic nerve; 9, ophthalmic artery. (Duke-Elder, Textbook of Ophthalmology.)
the sclera. Since the muscle pulls from above on an attachment behind the equator of the eye, it acts as a depressor.

The inferior oblique (Fig. 24.3) arises from the anterior part of the orbit, in the antero-medial corner of its floor. It passes laterally and backwards beneath the inferior rectus and is inserted into the posterolateral aspect of the globe. Pulling from below on an attachment behind the equator the inferior oblique thus acts as an elevator.

**Defining the Movements**

**Axes of Rotation**

In describing the actions of the muscles, we are concerned with changes in the direction in which the eye is 'pointing' i.e. the orientation of the fixation axis (defined as a line joining the point of fixation with the centre of rotation of the eye; Fig. 24.4). As a primary position or starting point, we may consider that position in which the eye is looking straight ahead when the head is erect. If the fixation axis swings horizontally, the eye is said to adduct or abduct, according as it swings towards or away from the nose; if the fixation axis swings vertically, the eye is elevated or depressed. After any purely horizontal or vertical movement of the fixation axis from the primary position, the eye is said to have reached a secondary position. If the eye executes a movement which causes both a horizontal and vertical displacement of the fixation axis (e.g. if the eye looks up and to the right) it is said to adopt a tertiary position.

Experiment has shown that the movements of the eye in general can be approximately described as rotations about a fixed point,\(^1\) the centre of rotation, situated some 13.4 mm behind the anterior surface of the cornea. To define a movement it is, of course, not sufficient to indicate the centre of rotation, but an axis, passing through the centre, about which the eye turns, must be given; thus adduction or abduction is achieved by rotation about a vertical axis, the z-axis (Fig. 24.5); elevation or depression by rotation about a transverse horizontal axis, the x-axis. The fixation axis can be made to point in any direction by rotating the eye first about one axis and then about the other—alternatively the necessary position of the eye can be attained by a single rotation about an axis intermediate between the x- and z-axes. It is worth noting that when the eye is in the primary position the x- and z-axes are in a vertical frontal plane—called Listing's plane (Fig. 24.5)—and that any direction of the fixation axis can be obtained by rotating the eye about an axis lying in this plane.

**Torsion or Rolling**

The physiologist is concerned not only with the direction of the fixation axis—which tells him where the eye is pointing—but also with the orientation of a certain fixed plane in the eye—the retinal horizon (Fig. 24.6).

Imagine the eye in the primary position looking straight ahead; a horizontal plane through the pole of the cornea is the retinal horizon and the image of any point in space lying on this plane falls on a horizontal line on the retina—the horizontal meridian. The retinal horizon, being fixed in relation to the eye, moves with it. Now we shall see that the appreciation of direction—of a line for example—depends in large measure on the directions the