In this chapter, we consider disorders that produce ocular motor dysfunction from involvement of the extraocular muscles. Some of these disorders affect only the extraocular muscles, whereas others are multisystem disorders in which various organ systems are also affected. The classification that is used is modified from Walton et al. (1), which should be consulted by readers interested in pursuing the subject of muscle disorders.

DEVELOPMENTAL DISORDERS OF EXTRAOCULAR MUSCLE

Agenesis of the Extraocular Muscles
Anomalies of Extraocular Muscle Location
Congenital Adherence and Fibrosis Syndromes

CONGENITAL MYOPATHIES

Background and Classification
Congenital Muscular Dystrophies
Congenital Adherence and Fibrosis Syndromes

MUSCULAR DYSTROPHIES

Congenital Muscular Dystrophies
Myotonic Muscular Dystrophies
Oculopharyngeal Muscular Dystrophy

ION CHANNEL DISORDERS

Myotonia

MITOCHONDRIAL MYOPATHIES (MITOCHONDRIAL ENCEPHALOMYOPATHIES)

Background
Mitochondrial Disorders Associated with External Ophthalmoplegia

Mitochondrial Genetics
Point Mutations of Mitochondrial tRNAs in Maternally Inherited Ophthalmoplegia
Single Deletions of mtDNA in Sporadic Ophthalmoplegia
Multiple Deletions of mtDNA in Autosomal-Dominant and Autosomal-Recessive Ophthalmoplegia
Diagnosis of Mitochondrial Myopathy in Patients with Ophthalmoplegia
ENCEPHALOMYOPATHY WITH OPHTHALMOPLEGIA FROM VITAMIN E DEFICIENCY
INFLAMMATORY MYOPATHIES
Infective Myositis
Idiopathic Myositis
ENDOCRINE MYOPATHIES
Graves’ Disease
Other Endocrine Myopathies
TRAUMATIC MYOPATHIES
OTHER MYOPATHIES

AGENESIS OF THE EXTRAOCULAR MUSCLES

Most cases of agenesis of the extraocular muscles involve only a single muscle. Isolated agenesis of the lateral rectus muscle (2), medial rectus muscle (2,3), inferior rectus muscle (4–7), superior rectus muscle (8), and superior oblique muscle (2,9) are all well described, particularly in children with craniosenosis (10–12). In some patients, agenesis of more than one muscle occurs (5,6).

ANOMALIES OF EXTRAOCULAR MUSCLE LOCATION

An abnormal insertion of an extraocular muscle is occasionally responsible for ocular motor dysfunction. In its mildest form, this may simply occur as a bifid insertion of
the medial (13), lateral (14), or superior rectus (15) muscles. The insertions of the superior and inferior oblique muscles vary widely (16), so it is often difficult to state when they are truly abnormal. Nevertheless, in some patients, the insertions of one or the other of these muscles are clearly abnormal. For example, the superior oblique tendon may insert on the undersurface of the superior rectus muscle, or the inferior oblique tendon may be attached to the lateral rectus muscle. The insertions of the four rectus muscles are much less variable, and thus abnormal insertions are more easily recognized (Fig. 22.1) (14,17). Strebel described monozygotic twins with fusion of the tendons of the superior and medial recti (18). Abnormal insertions of extraocular muscles, like agenesis of the muscles, often occur in children with craniostenosis (19).

Abnormal origins of extraocular muscles are quite rare. They appear to affect the inferior oblique muscle more than any of the other extraocular muscles (20).

Occasionally, an extraocular muscle shows underaction because of an abnormally increased length (21). In other instances, an anomalous muscle slip or fibrous band may be present (22) (Fig. 22.2). This phenomenon may be responsible for some cases of the superior oblique tendon sheath syndrome described by Brown (23). Patients with this syndrome show absence of elevation in adduction, improvement of elevation in the primary position, and normal or near-normal elevation in abduction (Fig. 22.3). Forced duction testing (see Chapter 18) shows mechanical limitation of motion upward and inward in the involved eye, but upward saccadic velocities are normal (24). Electromyographic (EMG) studies show no evidence of neuropathic abnormalities (25).

The cause of the congenital form of the superior oblique tendon sheath syndrome is unknown. The initial theory advanced by Brown (23)—that a short anterior sheath was caused by congenital paralysis of the inferior oblique muscle—is not supported by EMG studies, saccadic velocity studies, or findings at surgery (26). A restrictive band posterior and inferior to the globe may be responsible for Brown’s syndrome in most patients.

**CONGENITAL ADHERENCE AND FIBROSIS SYNDROMES**

Johnson (27) described two types of adherence syndromes associated with defective eye movements. In one type, there were adhesions between the sheaths of the lateral rectus and inferior oblique muscles that made it impossible to abduct the eye. The disorder was usually bilateral. The second type was characterized by adherence between the sheaths of the superior rectus and superior oblique muscles, preventing elevation of the affected eye.

Congenital fibrosis of the extraocular muscles (CFEOM) is quite rare (28–30). It is characterized by (a) ophthalmoplegia, (b) blepharoptosis, (c) fibrosis of all the extraocular muscles, (d) fibrosis of Tenon’s capsule, (e) adhesions between muscles, Tenon’s capsule, and globe, and (f) inelasticity and fragility of the conjunctiva. CFEOM is associated with mutations at three distinct loci, FEOM1, FEOM2, and FEOM3, located on chromosomes 12, 11, and 16, respectively (31–34).

Autosomal-dominant CFEOM is associated with heterozygous mutations of the FEOM1 or FEOM3 locus (31–33). The proteins encoded by the FEOM1 and FEOM3 genes have not been identified (31,33). FEOM1 mutations are associated with the CFEOM1 phenotype, which is characterized by (a) ptosis, (b) eyes fixed 20°–30° below the horizontal (infraduction), (c) absence of elevation or depression of the eyes, (d) little or no horizontal movement with an eso- or