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Imaging Anatomy and Pathology of Extraocular Muscles in Adults

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Abstract

The extraocular muscles (EOM) are involved in a variety of disease processes with characteristic findings on imaging. EOM anatomy is described, followed by a review of adult EOM pathology. The imaging characteristics are explained with examples. The pattern of EOM disease on imaging, in corroboration with clinical findings, can often lead the radiologist towards a specific diagnosis.

Résumé

Les muscles extrinsèques de l'œil peuvent faire l'objet de divers processus morbides qui présentent des caractéristiques d'imagerie précises. Cette étude décrit les caractéristiques anatomiques des muscles extrinsèques de l'œil, puis passe en revue les caractéristiques pathologiques associées à ces structures chez l'adulte. Les éléments d'imagerie sont par ailleurs appuyés par des exemples. Les caractéristiques d'imagerie propres aux affections des muscles extrinsèques de l'œil, lorsqu'elles sont confirmées par des observations cliniques, permettent souvent au radiologiste de poser un diagnostic précis.

Key Words: Extraocular muscles; Orbits

The extraocular muscles (EOM) are implicated in a variety of local and systemic diseases. Often the pattern of disease on imaging, along with the clinical presentation, can lead the radiologist towards a specific diagnosis. This article provides a comprehensive review of adult EOM pathologies. The unique imaging characteristics of a variety of EOM diseases are demonstrated.

Normal Anatomy

The orbit contains the globe and the retrobulbar space. Within the retrobulbar space are 6 EOMs that control eye movement; the superior, inferior, medial, and lateral recti; and the superior and inferior oblique muscles. A seventh orbital muscle, the levator palpebrae superioris, attaches to the upper tarsal plate. All are controlled by the oculomotor nerve except the superior oblique (trochlear IV nerve) and the lateral rectus (abducens VI nerve). Together, the EOMs form a muscular cone with its base at the posterior globe and its apex at the superior orbital fissure. This cone divides the retrobulbar space into extraconal and intraconal spaces (Figure 1). The extraconal space contains the lacrimal gland and fat. Inflammatory or neoplastic lesions of the lacrimal gland as well as sinus-related inflammation can involve this space. The intraconal space contains the optic nerve sheath complex. Lesions such as optic nerve sheath gliomas or meningiomas can occur here. The superior ophthalmic vein spans both the extraconal and intraconal spaces. The inferior ophthalmic vein arises from a venous plexus in the mid orbit, between the optic nerve and inferior rectus muscle, and courses posterior within the intraconal space. It curves upward to join the superior ophthalmic vein within the posterior orbit [1].

Graves Ophthalmopathy

The most common cause of proptosis in adults is Graves ophthalmopathy (thyroid-associated orbitopathy, thyroid ophthalmopathy, thyroid-related immune orbitopathy). This

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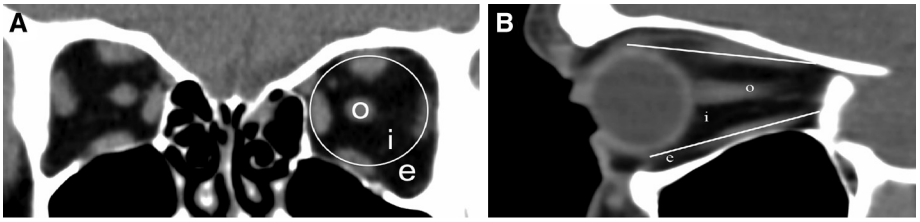

Figure 1. (A) Coronal computed tomography (CT) image of the normal orbit anatomy. The circle marks the cone created by connecting the EOMs, which forms a border between the extraconal and intraconal spaces. (B) Sagittal CT image of the same patient. e = extraconal space; i = intraconal space o = optic nerve.

condition is commonly associated with autoimmune hyperthyroidism but can occur in patients with euthyroid or hypothyroid thyroiditis. Clinically, patients with Graves ophthalmopathy can present with eyelid swelling, ocular dryness, grittiness, photophobia, excessive tearing, diplopia, and a pressure or aching sensation behind the eyes. Features on examination include eyelid retraction, eyelid oedema, periorbital and conjunctival erythema, and proptosis. Graves ophthalmopathy is often bilateral with asymmetric involvement of the EOM but can be unilateral in 5%-14% of patients [2]. In 5% of patients, congestion within the orbit may lead to compressive dysthyroid optic neuropathy, which is potentially blinding [3].

Orbital imaging with computed tomography (CT) or magnetic resonance imaging (MRI) classically reveals disproportionate spindle-shaped enlargement of the EOMs with relative sparing of the tendinous globe attachments (Figure 2). The inferior rectus is most frequently involved, followed by the medial, superior and lateral recti, and superior oblique muscles [4]. Visualization of the morphology of EOMs is comparable between CT and MRI, and is optimal on coronal views. In addition to EOM changes, other findings of Graves ophthalmopathy can include increased retrobulbar fat, lacrimal gland enlargement, eyelid oedema, stretching of the optic nerve, and tenting of the posterior globe.

Compared with CT, MRI provides the added advantage of differentiating between the acute and chronic phases of Graves ophthalmopathy. In the early acute inflammatory stage, the EOMs are oedematous and demonstrate high signal intensity on short tau inversion recovery imaging. Short tau inversion recovery signal intensity, measured as a ratio between the involved EOMs and the adjacent temporalis muscle, has been shown to correlate with clinical

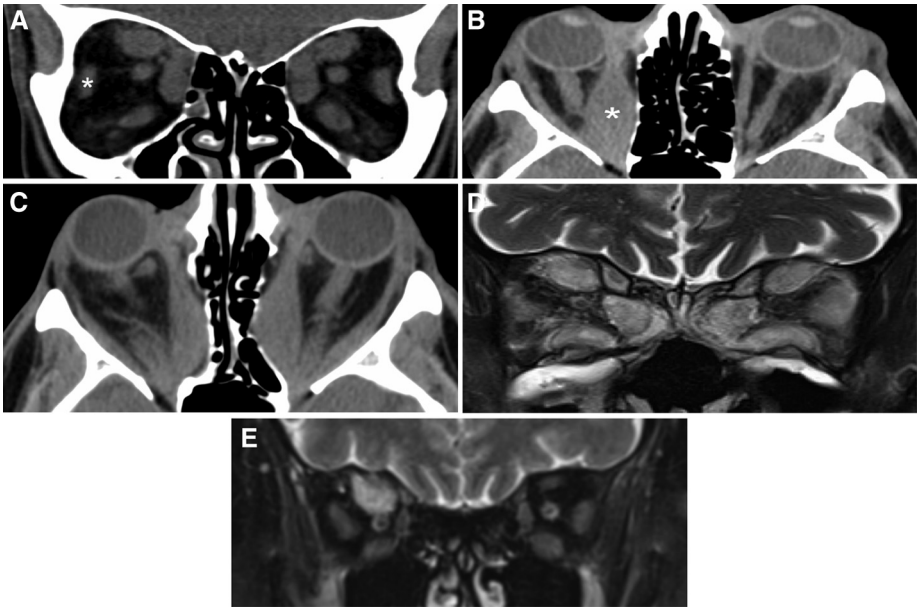

Figure 2. (A) A 46-year-old woman with Grave disease presented with bilateral proptosis. A coronal computed tomography (CT) image, reveals enlarged bilateral medial and superior recti, bilateral superior oblique muscles, and left inferior rectus. The lateral recti (especially the right [asterisk]), the inferior oblique muscles, and the right inferior rectus are spared. (B) A 54-year-old man who presented with proptosis from Graves ophthalmopathy. An axial CT image, revealing thickening of the right medial rectus (asterisk), with relative sparing of its tendinous attachments to the globe. The right globe is displaced medially with an abnormally oriented lens. The optic nerve also is displaced by mass effect. (C) The same patient in (B) after decompressive surgery. An axial CT image, showing bilateral lamina papyracea resection. The left medial rectus was noted to have markedly enlarged in the interval since the prior study. (D) Coronal T2-weighted magnetic resonance image (MRI) of an 81-year-old woman with a history of Graves ophthalmopathy and prior orbital decompression. All EOMs are enlarged and hyperintense, which suggests acute inflammation. (E) A coronal T2-weighted MRI of a 64-year-old woman with a history of Graves ophthalmopathy, demonstrating enlargement and increased signal of the right superior rectus, consistent with acute inflammation. Note the lateral and inferior recti are enlarged bilaterally but do not show increased inflammatory signal.