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Traumatic longitudinal splitting of the inferior rectus muscle

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Abstract

Orbital floor fractures and associated injuries can cause strabismus. We present the case of a 34-year-old man with incomitant strabismus following orbital reconstruction after a high-impact baseball injury. Multipositional, high-resolution magnetic resonance imaging (MRI) revealed extensive longitudinal splitting of the inferior rectus muscle by an orbital floor implant that separated its orbital and global layers.

Case Report

A 34-year-old man presented to the Jules Stein Eye Institute for evaluation of restrictive strabismus. He had been standing in a batting cage 15 months earlier and was hitting a pitched baseball when he was struck on the left inferior orbital rim when the ball ricocheted from a metal pole less than 2 m away. This high-impact injury fractured the left medial and inferior orbital walls, obliterating the left maxillary sinus. The resulting orbital distortion extended the length of the maxillary bone, involving deep posterior structures. Five months later, a porous polyethylene plate was inserted in the inferior orbit at another institution for which records were unavailable. The patient was referred for strabismus evaluation and high-resolution magnetic resonance imaging (MRI) before additional orbital reconstruction. The patient complained of vertical, binocular diplopia in all gazes except infraversion. On examination, visual acuity was 20/20 in each eye. Orthoptic evaluation was notable for a 2^Δ right hypertropia in primary gaze. There was 12^Δ left hypertropia and 4^Δ exotropia in dextroversion, and there was 4^Δ right hypertropia and 8^Δ esotropia in levoversion (Figure 1). In sursumversion, there was 15^Δ exotropia with 10^Δ right hypertropia. The patient was orthotropic in deorsumversion. On external evaluation, he elevated his chin to achieve single binocular vision. He exhibited 4 mm left enophthalmos with left midfacial depression.

Following clinical evaluation, a high-resolution MRI was performed in multiple gaze positions using surface coils as previously described.¹ MRI demonstrated that the orbital floor was extensively disrupted. Orbital fat and the posterior segment of the inferior rectus muscle were deeply displaced into the maxillary sinus, with the inferior rectus muscle tethered superiorly only by its motor nerve (Figure 2). Coronal sections of the orbits in

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Figure 2 show vertical elongation of the entire orbit with significant inferior displacement of orbital contents. Although all extraocular muscles contracted appropriately as evidenced by thickening of their bellies in their fields of action, the left inferior rectus muscle was markedly narrowed at its insertion on the globe. Sagittal MRI confirmed a longitudinal splitting of the inferior rectus in a plane consistent with the division between the orbital and global layers (Figure 3). The unique finding in this case was the discovery that the orbital implant physically separated two layers of the inferior rectus muscle (Figures 2 and 3). The inferior half of the inferior rectus muscle terminated in the left lower lid, while the attenuated superior portion retained continuity with the sclera.

Discussion

Although the timing and indications for surgical repair of orbital floor fractures are controversial, it is common practice to place an orbital floor implant as part of the initial reconstruction.² Repair of the bony structures alone may release restrictions and restore orbital contents to their anatomic locations; however, after large fractures, more than 50% of patients require subsequent strabismus surgery to alleviate persistent diplopia.² Causes may include extensive scarring, edema, and distortion of orbital anatomy that can limit surgical identification of landmarks.

Correction of strabismus caused by large orbital fractures can be challenging. Patients may have undergone several orbital surgeries and may present months to years after initial injury. Possible etiologies of strabismus in this setting include soft-tissue entrapment, ischemia, hemorrhage, fibrosis, and nerve or muscle damage. Several of these factors often contribute to varied patterns of ocular misalignment. Ludwig and colleagues² have described a longitudinal splitting of a rectus muscle between its anatomic global and orbital layers and termed it a “flap tear.” The characteristics of these injuries included a missing segment of muscle or tendon, evidenced by a narrowing of the remaining attachment, and a missing or destroyed muscle. Although these findings can sometimes be observed at the time of surgery, it is advantageous to be aware of this injury prior to surgical planning. High-resolution MRI may be diagnostic. It has been supposed that if a flap-tear heals anteriorly, it may cause a tetherlike restriction along the affected muscle’s direction of action.³ That was not the case here: the plate created a mechanical barrier preventing anterior healing, so that no mechanical tether developed to restrict infraduction. Longitudinal splitting of the inferior rectus muscle in the plane separating the orbital and global layers would not necessarily compromise the contractile function of the oculorotatory global layer, accounting for preservation of active infraduction by the inferior rectus muscle.

It is not known when splitting of the inferior rectus muscle occurred in the present case. It could have occurred during the initial injury when supporting connective tissues and pulleys were forced inferiorly, tearing the inferior rectus muscle orbital layer from the global layer. Alternatively, it could have occurred at the time of later surgery, during insertion of the plate. There is no doubt the severity of this injury was associated with extensive adhesions, edema, and surgical landmark distortion that would have confounded identification of normal anatomy. Without orbital imaging, it might have been erroneously concluded there was fibrotic restriction to supraduction since this limitation remained despite repair of the orbital floor. MRI findings suggest potential benefit from removal or repositioning of the current plate, with an effort to rejoin the two segments of the inferior rectus muscle should further surgical correction be attempted. However, extensive persistent fibrosis makes it unlikely that unrestricted ductions can be restored entirely for the left eye.

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FIG 1.
Versions in diagnostic gaze positions showing incomitant strabismus following severe injury of the left orbital floor with splitting of the inferior rectus.

FIG 2.

Coronal MRI comparing normal right orbital architecture with that of traumatized left orbit following floor fracture repair with a polyethylene implant. The inferior rectus muscle is longitudinally split with the orbital implant physically separating its orbital and global layers.

FIG 3.

High-resolution sagittal plane MRI of left orbit after orbital floor fracture with inferior plate repair. The orbital and global segments of the inferior rectus muscle are separated longitudinally by the orbital plate implant. *LPS*, levator palpebrae superioris; *ON*, optic nerve; *SR*, superior rectus muscle.