• Letter to the Editor •

Traumatic isolated medial rectus muscle rupture associated with an anatomic insertional variation: a case report

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Dear Editor,

Traumatic injury to the extraocular muscles is uncommon and is usually associated with severe orbital trauma such as traffic accidents, blunt facial injury, or iatrogenic causes including sinus surgery[1-3]. Complete rupture of an extraocular muscle without associated orbital fracture or other orbital structural damage is rare[4-5].

We report a case of isolated medial rectus (MR) muscle rupture following blunt trauma from a bicycle handlebar without associated orbital injury. In this case, the rupture was suspected to be related to an anatomical variation of the MR muscle insertion[6], and the injured muscle was successfully repaired by direct end-to-end anastomosis, resulting in favorable functional recovery. In traumatic cases, isolated extraocular muscle rupture can lead to ocular motility disturbance and diplopia. Therefore, understanding the possible mechanisms of isolated extraocular muscle injury and appropriate surgical approaches is clinically important. We describe the clinical findings, surgical management, and anatomical considerations of this case.

Ethical Approval This study was approved by the Institutional Review Board of Hospital (IRB No. 2026-03-005) and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from the patient for publication of this case report and accompanying images.

Case Report A 57-year-old woman with no significant medical history presented to the emergency department with right eye pain and diplopia following a bicycle accident. She reported falling during her morning commute and sustaining direct blunt trauma to her right eye from the bicycle handlebar. On initial ophthalmologic examination, severe periorbital bruising and edema were observed in the right eye (Figure 1A). Best corrected visual acuity was 20/30 in the right eye and 20/20 in the left eye. Intraocular pressure measured 25 mm Hg in the right eye and 15 mm Hg in the left eye. Ocular motility examination revealed approximately 40 prism diopters of right exotropia in primary gaze, with profound limitation of adduction graded as -4. Additional limitations of elevation and depression graded as -2 were also noted in the right eye (Figure 1B). Slit lamp examination demonstrated diffuse subconjunctival hemorrhage in all quadrants. In the medial conjunctival area, a large blood clot and Tenon's capsule laceration were observed, raising suspicion of MR muscle rupture. The axial orbital computed tomography revealed mild retrobulbar hemorrhage and disruption of the MR muscle body, with posterior displacement of the muscle toward the orbital apex (Figure 1C). The coronal view near the orbital apex further confirmed the retracted muscle, while demonstrating that the adjacent orbital structures, including the globe, optic nerve, orbital walls, and other extraocular muscles, were intact (Figure 1D).

Fundus examination showed inferior commotio retinae and subretinal hemorrhage in the right eye, without evidence of retinal tear or globe rupture (Figure 2A). Based on the clinical and radiologic findings, the patient was diagnosed with traumatic isolated MR muscle rupture, and emergent surgical repair was planned. Under general anesthesia, surgical exploration revealed a full-width rupture of the MR muscle with external exposure and signs of necrosis

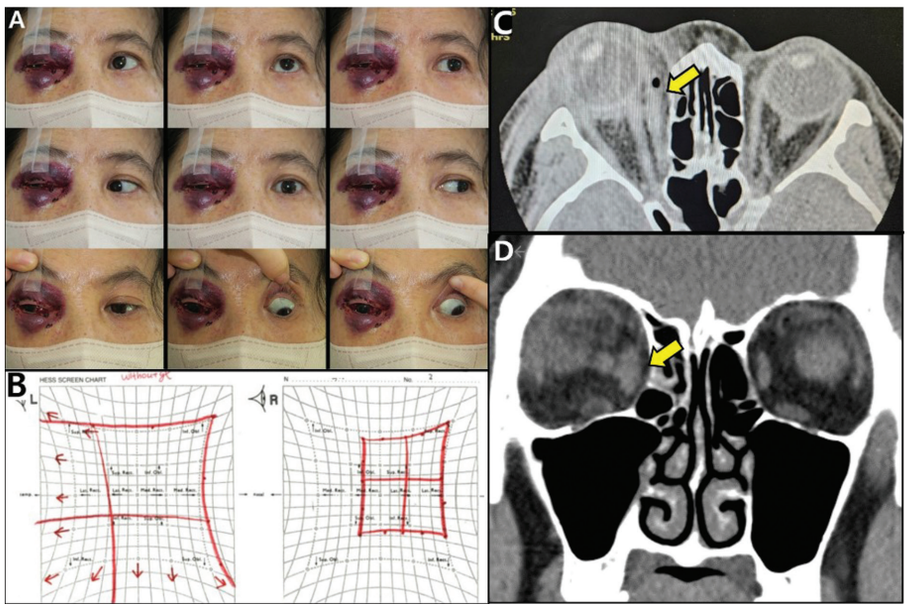

Figure 1 Initial clinical presentation and imaging findings after blunt orbital trauma A: External photographs showing severe periorbital ecchymosis and edema of the right eye following blunt trauma. Ocular motility examination demonstrating marked right 40 prism diopters exotropia with profound limitation of adduction and additional limitation of vertical movements. B: Hess screen test revealed limitation of adduction and additional limitation of vertical movements. C: Axial orbital computed tomography revealing disruption of the medial rectus muscle body with posterior displacement toward the orbital apex (yellow arrow). D: Coronal orbital computed tomography near the orbital apex further confirming the retracted muscle (yellow arrow), while demonstrating the intact adjacent orbital structures, including the globe, optic nerve, orbital walls, and other extraocular muscles.

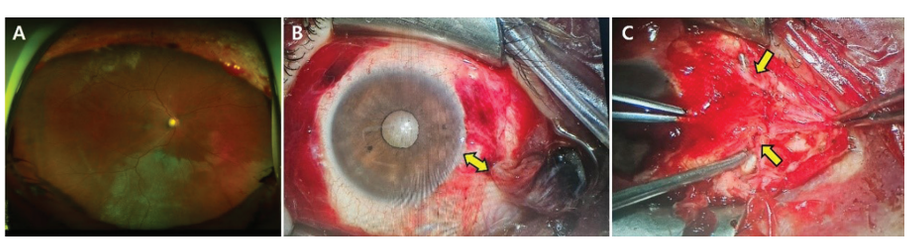

Figure 2 Fundus and intraoperative findings of medial rectus (MR) muscle rupture A: Fundus photograph of the right eye demonstrating mild superior and more prominent inferior commotio retinae with associated subretinal hemorrhage, without evidence of retinal tear or globe rupture. B: Intraoperative photograph demonstrating full-width rupture and necrosis of the anterior portion of the MR muscle. The MR insertion was located unusually close to the cornea, with a 2.5 mm distance between the corneal limbus and the MR insertion (yellow arrow), suggesting a possible anatomic insertional variation. C: Intraoperative view showing identification of the posterior muscle fibers and reattachment to the anterior MR muscle stump (yellow arrows).

(Figure 2B). The anterior insertion of the MR muscle was located approximately 2.5 mm from the limbus, indicating an unusually anterior insertional variation. The posterior portion of the MR muscle was not immediately identified as it had retracted into the orbit. The posteriorly displaced muscle fibers were carefully approached along the medial orbital wall toward the orbital apex. Fragmented and retracted MR muscle fibers were identified within the surrounding Tenon's capsule tissue[7]. After trimming the irregular muscle edges, the posterior muscle fibers were sutured to the anterior MR muscle body using 6-0 Vicryl sutures. The conjunctiva was closed, and subconjunctival dexamethasone (4 mg/1.0 mL) was administered (Figure 2C).

Postoperatively, the patient remained stable. Best corrected visual acuity improved to 20/20 in the right eye, intraocular pressure normalized to 15 mm Hg, and the periorbital edema and ecchymosis gradually improved. At the 5mo follow-up, ocular alignment showed a residual right exotropia of approximately 12 prism diopters. The previously noted limitation of adduction in the right eye improved to approximately -0.5 (Figure 3A). Although a small residual exotropia remained, the patient did not report diplopia and was satisfied with the surgical outcome. She was therefore managed with observation without additional treatment, and the clinical findings remained stable. Follow-up fundus examination revealed no new abnormalities (Figure 3B).

DISCUSSION

Epidemiologically, the MR muscle is the most frequently

Figure 3 Postoperative clinical outcome A: Postoperative ocular motility examination at 5mo showing significant improvement in eye movements with minimal residual exotropia of 12 prism diopters and limitation of adduction of the right eye to approximately -0.5. B: Follow-up fundus photograph demonstrating resolution of the previous commotio retinae with stable retinal findings and no additional pathology.

injured extraocular muscle in ocular trauma, followed by the inferior rectus (IR) muscle[8-10]. However, isolated MR muscle rupture following blunt trauma without associated orbital fractures or other ocular structural injury is rarely encountered. The MR muscle may be particularly vulnerable to traumatic injury because it is the rectus muscle located closest to the limbus and lies adjacent to the medial orbital wall[6]. In addition, the MR muscle has the shortest tendon among the rectus muscles, measuring about 4 mm, whereas the lateral rectus tendon is the longest at about 8 mm[6]. These anatomical features may increase its susceptibility to rupture when exposed to direct blunt force to the anterior globe, as observed in the present case[11].

Anatomically, the rectus muscles insert around the limbus in a characteristic pattern known as the spiral of Tillaux, with the MR located closest to the cornea[6,12-13]. The MR muscle typically inserts approximately 5–6 mm posterior to the limbus. In a cadaveric study evaluating the accuracy of the spiral of Tillaux, Kim *et al*[12] reported a mean MR insertion distance of 5.28 mm from the limbus. Similarly, intraoperative measurements reported by Liu *et al*[13] demonstrated that the MR insertion ranges approximately from 4.5 to 6.1 mm posterior to the limbus, indicating that some anatomical variability exists. In the present case, the MR insertion was located unusually close to the cornea, which may have contributed to the vulnerability of the muscle to traumatic rupture following blunt ocular trauma. Anatomical variations of the MR muscle have been reported. Lee and Kim[14] described an accessory MR muscle in a patient with strabismus convergens, and congenital anomalies such as dystrophic or absent MR muscles have also been reported[15-16]. However, an anterior MR insertion as close as 2.5 mm from the limbus, as observed in the present case, has not been previously reported.

Several studies have reported cases of extraocular muscle rupture[1-3,12]. Chen *et al*[4] analyzed 36 cases of total extraocular muscle rupture, among which only two cases involved isolated MR muscle rupture without other ocular structure injury, highlighting the rarity of this condition. The previously reported cases occurred after sinus surgery and a traffic accident, indicating relatively severe mechanisms of injury. In contrast, the present case occurred after low-impact blunt trauma, when the patient sustained a direct impact to the eye from a bicycle handlebar. This suggests that the unusual anatomical characteristics of the MR muscle in our patient may have contributed to the occurrence of total rupture. Notably, the present case demonstrates an uncommon combination of isolated MR muscle rupture following relatively low-impact trauma, in association with an unusually anterior insertion of the MR muscle, which may represent a previously unrecognized anatomical risk factor.

Regarding surgical management, Chen *et al*[4] reported that most rectus muscle ruptures occur 3–8 mm posterior to the tendon insertion, with the proximal muscle stump typically surrounded by Tenon's capsule. When the posterior muscle stump can be identified, direct end-to-end muscle anastomosis is recommended. If the proximal muscle cannot be located, alternative procedures such as rectus muscle transposition or antagonist recession may be considered.

Previous reports have described several surgical strategies for identifying the posterior stump in cases of rectus muscle rupture[2]. These approaches can be broadly categorized into three methods: careful preoperative evaluation of the anatomical course using imaging studies, identification of anatomical clues from adjacent structures during surgery, such as the shared sheath attachment between the IR muscle and inferior oblique muscle[2] or the course of the MR muscle along the medial orbital wall[7,17], and generated muscle force duction testing (GDT). During GDT, the surgeon may feel contraction of the muscle when the patient attempts to look in the direction of the muscle's action[18]. In the present case, GDT was impractical due to general anesthesia. Preoperative imaging and cautious dissection along the intact medial orbital wall enabled identification of a portion of the posterior MR muscle, allowing direct anastomosis with a favorable surgical outcome.

In conclusion, clinicians should recognize that extraocular muscle rupture may occur even without orbital fractures. Possible mechanisms include direct trauma from a sharp

object or anatomical variations, such as an MR muscle insertion located closer to the cornea, as observed in our case. Careful preoperative evaluation with multimodal imaging and meticulous intraoperative identification of the ruptured posterior muscle segment may improve surgical planning and lead to more favorable functional outcomes.

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