Lower Blepharoplasty Using Bony Anatomical Landmarks to Identify and Avoid Injury to the Inferior Oblique Muscle

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In the resection of redundant orbital fat during lower blepharoplasty, selective excision is performed from the medial, central, and lateral compartments. During transcutaneous blepharoplasty, the inferior oblique muscle is susceptible to injury because of its intimate association between the medial and central compartments. When performing a transconjunctival approach, the inferior oblique muscle is even more susceptible to injury because it lies in the direct path of dissection for fat pad exposure. Injury to the inferior oblique muscle can result in symptoms ranging from transient diplopia to a more debilitating permanent strabismus. Fresh cadaver heads were used to identify bony anatomical landmarks that would help to more accurately define the origin and body of the inferior oblique muscle. The orbital rim, infraorbital foramen, and supraorbital notch were chosen as guideline landmarks. The origin of the inferior oblique muscle was designated with respect to the above structures, and the muscle course was delineated. The inferior oblique muscle originates on the orbital floor, 5.14 ± 1.21 mm posterior to the inferior orbital rim, on a line extending from the infraorbital foramen to 10 ± 0.9 mm inferior to the supraorbital notch along the supramedial orbital rim. The muscle belly extends from this origin to its insertion into the posterolateral globe in an oblique direction toward the lateral canthal area. Identification of the orbital rim, infraorbital foramen, and supraorbital notch more accurately localizes the origin and course of the inferior oblique muscle, which may facilitate fat resection during lower blepharoplasty by preventing morbidity associated with inferior oblique muscle injury. (Plast. Reconstr. Surg. 110: 1318, 2002.)

Unlike upper blepharoplasty, lower blepharoplasty is more likely to involve fat excision and thus is more prone to extraocular muscle injury.1 Injury to the inferior oblique muscle remains an infrequent but debilitating complication of lower blepharoplasty. Reported mechanisms of extraocular muscle injury following lower blepharoplasty have included intramuscular hemorrhage and edema, cicatricial changes within the muscle secondary to partial resection or cautery, and incorporation of the muscle into closure of the orbital septum.3 Similar injuries to the inferior oblique muscle have been reported following traumatic injury to the orbit4-8 and as complications of eye surgery.9 When transient, diplopia is usually secondary to significant swelling and ecchymosis.1 Unfortunately, prolonged diplopia can indicate injury to extraocular muscles that involves intramuscular hemorrhage caused by rough handling of tissues or some degree of transection.1 It has been suggested that transection of less than 50 percent of the muscle fibers will not result in permanent diplopia.1 A thorough knowledge of anatomy and the use of precise technique are the only recommendations reported to avoid this type of injury.10

During transcutaneous orbital fat excision, the inferior oblique muscle is prone to injury because it lies intimately between the medial and central fat compartments.11 (Fig. 1.) Furthermore, the inferior oblique muscle is more vulnerable to injury by virtue of its transverse orientation as compared with longitudinally oriented extraocular muscles. The transconjunctival approach has been promoted in an attempt to avoid external incisions and to min-
imize the risk for lower eyelid retraction. Moreover, the transconjunctival approach has been advocated as a safe alternative to the transeptaneous approach, with one study of 1200 lower blepharoplasty patients finding no cases of postoperative diplopia. Yet, inferior oblique muscle injury has been documented during the transconjunctival approach and is often associated with an injury to the inferior rectus muscle as well.

The inferior oblique muscle can be acutely injured during dissection, cauterization, or ligation of the orbital fat pads from the medial and central compartments. The diagnosis of inferior oblique muscle injury is made primarily by physical examination. Orthoptic measurements can be used to quantify limitations in range of motion. In addition, magnetic resonance imaging can identify edema or cictrization of the inferior oblique muscle. Partial injuries usually heal without intervention, demonstrated by resolution of symptoms by 6 months postoperatively. In contrast, complete transection results in persistent strabismus and can be diagnosed by visual field examination. Inferior oblique muscle surgery is required to repair such injuries.

Patients with inferior oblique muscle injury will complain of diplopia that is characterized by a distorted visual image with an upward lateral gaze. Patients may take on a chin-up or head-tilt position in an effort to alleviate their symptoms. Typically, this muscle is only partially cauterized and/or stretched from external compression. In such cases, diplopia symptoms have been reported to spontaneously resolve over 1 to 2 months. However, nearly complete or complete muscle transection requiring surgical repair has been reported.

**METHODS**

Orbital structures were carefully dissected in seven fresh cadaver heads. The orbital rim, infraorbital foramen, and supraorbital notch were identified by palpation and dissection. These bony landmarks were used to predict the location of the origin of the inferior oblique muscle tendon on the orbital floor. The origin was first measured in millimeters posterior to the palpable inferior orbital rim. The origin was next defined using an oblique line based on anatomical landmarks dictated by the infraorbital foramen and supraorbital notch (Fig. 1). Subsequently, the muscle body of the
inferior oblique muscle from its origin to its insertion into posterolateral globe was then delineated. All measurements were obtained with 4.0-power loupe magnification.

RESULTS

The inferior oblique muscle was determined to originate over the orbital floor, $5.14 \pm 1.21$ mm posterior to the inferior orbital rim, on a line extending from the infraorbital foramen to $10 \pm 0.9$ mm inferior to the supraorbital notch along the supramedial orbital rim (Fig. 1). The muscle body was observed to extend from this origin to the posterolateral direction toward the lateral canthal area (Fig. 2).

DISCUSSION

A thorough knowledge of lower eyelid anatomy has been advocated as the most effective preventive measure to avoid inferior oblique muscle injury. The inferior oblique muscle has been described to originate from the medial orbital floor posterior to the lacrimal fossa and to insert into the posterolateral, inferior quadrant of the globe, thus providing superomedial rotation of the globe. Unfortunately, this anatomical description involves deeper structures that are not identifiable during a surgical approach involving a superficial to deep dissection. In contrast, the lateral facial extensions of the inferior oblique muscle sheath and Lockwood's ligament forming the so-called arcuate expansion have been well delineated.

Even though this expansion separates the lateral and central fat compartments by inserting on the anterolateral orbital rim, injury to the arcuate expansion has not been documented. In fact, few surgeons advocate transection of the arcuate expansion to create a continuous visibility of the central and lateral fat pads for ease of fat resection. Moreover, unlike the inferior oblique muscle origin, the arcuate expansion is discernible behind the skin of the lateral aspect of the lower eyelid as a relatively horizontal, linear indentation, and, consequently, its injury is avoidable.

In addition to knowledge of anatomy, a meticulous surgical technique may avoid complications in lower blepharoplasty. When performing a transcutaneous approach, partial resection of the central fat pad that overlies the capsule of the medial fat pad often exposes the body of the inferior oblique muscle. The medial fat compartment may be difficult to locate, necessitating partial resection of the central fat pad before gaining access to the medial fat compartment. Transcutaneous incisions are placed along a continuous line $2$ mm below the cilia within a natural crease. The orbital fat can be approached through small orbital septum openings directly over each fat compartment or by opening the entire orbital septum. Careful technique must be used during the teasing out process of the fat lobules. Gentle pushing on the globe with the eyelids shut may be used to detect the most prominent aspect of

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![Supraorbital notch](image)

Fig. 2. A fresh cadaveric head demonstrating the origin and course of the inferior oblique muscle based on the orbital rim, infraorbital foramen, and supraorbital notch.
fat herniation before excision.21 Moreover, only limited traction on fat pads is advocated during resection as an attempt to minimize distortion of the anatomy and inadvertent injury to vital structures. One should avoid thrusting forceps or scissors deep within the fat compartment, which could result in bleeding or inferior oblique muscle injury.21 During fat resection, inferior oblique muscle injury can be avoided by resecting only fat that protrudes anterior to the septum, because extraocular muscles do not bulge beyond the septal plane.

During resection, clamping and cauterezation of bulging fat lobules before excision has been described. However, clamping of fat lobules does not ensure that all vessels will be adequately cauterized. An uncauterized fat lobule retracting into the deep compartments will necessitate blind cauterization, during which inferior oblique muscle injury may result. Accordingly, bipolar cauterezation seems to provide a safer alternative to the "clamp and Bovie cauterezation" technique of fat excision.

When performing a transconjunctival approach, the inferior oblique muscle is even more susceptible to injury because it lies in the direct path of dissection for fat exposure. The inferior oblique muscle is interposed between the inner lamina and the fat pads. The inner lamina is comprised of the conjunctiva and lower-eyelid retractors, including the capsulopalpebral fascia, inferior tarsal muscle, and inferior oblique muscle posterior sheath.10 The proximity of the inferior oblique muscle to the conjunctiva creates the risk of injecting the anesthetic into the muscle, which typically results in transient diplopia.20 In addition, even the initial incision of the inferior conjunctival fornix may result in direct injury to the inferior oblique muscle.13 Consequently, various surgical maneuvers have been proposed in an effort to minimize the incidence of inferior oblique muscle injury.

Avoidance of a very low incision near the inferior fornix has been suggested to decrease the risk of inferior oblique muscle injury. Various authors have stressed that the transconjunctival incision should be placed on the eyelid side of the inferior fornix.22-24 Specifically, this incision should be placed 10 mm inferior to the corneoscleral limbus on the eyelid side.22-24 Many surgeons advocate the deliberate identification of the muscle early during the procedure before fat resection.19 Also, an "open sky" transconjunctival incision such that all of the fat pockets and the inferior oblique muscle are laid out can simplify this identification step.20 No healing complications have been documented with the continuous or the discontinuous conjunctival incision.25 Finally, before fat excision, gentle traction can be applied to the fat pads intended for resection to confirm a lack of ocular globe movement and, thus, lack of a muscular component in the tissue being resected.13

With the transcutaneous approach, the inferior oblique muscle is the most frequently reported extraocular muscle injured.13,20 Interestingly, two reported series using the transconjunctival approach reported the same frequency between injury to the inferior rectus and the inferior oblique muscle.13,19 Concomitant injury to the inferior rectus and inferior oblique muscle may be related to these muscles sharing a common tendon sheath that forms a portion of Lockwood’s suspensory ligament, thus allowing for a single maneuver to result in injury to both structures.13

Delineating the location of the inferior oblique muscle before making any incision is critical to avoiding injury to the muscle. Previously, the origin of the inferior oblique muscle was defined by a deep bony landmark; i.e., the lacrimal fossa.18 Recently, the inferior oblique muscle location has been described based on more superficial soft-tissue landmarks. Specifically, the origin of the inferior oblique muscle was found 9.4 mm lateral to the medial canthus and its insertion 21.7 mm lateral to the medial canthus.24 We believe that superficially identifiable bony landmarks can provide more reliable anatomical reference points when compared with soft-tissue landmarks, because bony landmarks are not mobile and are unaffected by the soft-tissue migration associated with aging. When resecting orbital fat during lower blepharoplasty, identification of the orbital rim, infraorbital foramen, and supraorbital notch can aid in delineating the origin and course of the inferior oblique muscle. The inferior oblique muscle can be found to originate on the orbital floor 5 mm deep to the inferior orbital rim on a line extending from the infraorbital foramen to a point on the superomedial orbital rim 1 cm below the supraorbital notch. The muscle belly extends from this origin to its insertion on the postero-lateral aspect of the globe on an oblique transverse line toward the lateral canthal area. Identifying these bony landmarks may help prevent
morbidity associated with inferior oblique muscle injury in lower blepharoplasty patients.

CONCLUSIONS

Injury to the inferior oblique muscle remains an infrequent but potentially debilitating complication of lower blepharoplasty. We investigated fresh cadaver heads to establish bony landmarks for delineating the location of the inferior oblique muscle that could serve as a guide for avoiding inadvertent injury to this muscle. Identification of the orbital rim, infraorbital foramen, and supraorbital notch may facilitate the approach to lower eyelid fat resection by minimizing risk of injury to the inferior oblique muscle during lower blepharoplasty.

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