A Vision Center of Excellence newsletter focused on ocular casualty care and readiness

FRONTLINES OF EYE CARE

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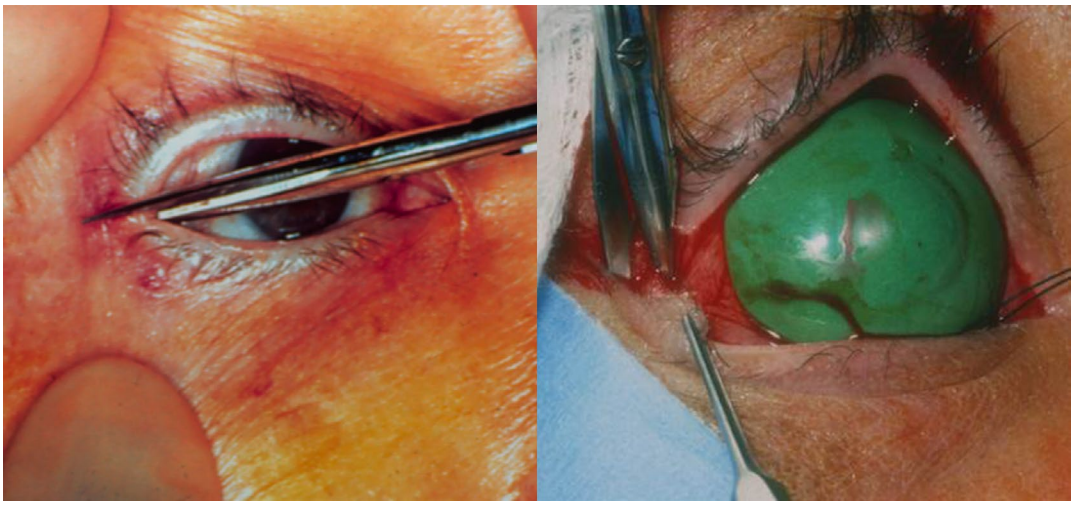
IN THIS ISSUE



Lateral canthotomy and inferior cantholysis is the most effective method of treating an orbital compartment syndrome. Note that the inferior cantholysis incision (right) must be a full-thickness cut. (Source: James W. Karesh, MD)

FEATURE

EMERGENCY TREATMENT OF AN ACUTE ORBITAL COMPARTMENT SYNDROME: LATERAL CANTHOTOMY AND INFERIOR CANTHOLYSIS

Acute orbital compartment syndrome (OCS) is an ocular emergency, which without immediate intervention, will result in complete and irrecoverable loss of vision. The immediate cause for vision loss is retinal and optic nerve ischemia caused by vascular compression resulting from a rapid rise in intraorbital pressure associated with an acute volume expansion of the intraorbital contents. Permanent vision loss can only be prevented by an immediate reduction in intraorbital pressure and restoration of vascular flow. This is most effectively and efficiently achieved through an emergency lateral canthotomy and inferior cantholysis of the lateral canthal tendon (canthotomy and cantholysis) carried out within 60-90 minutes of the onset of symptoms or clinical signs of an OCS. When properly performed, a canthotomy and cantholysis allows the orbital contents and globe to expand anteriorly, effectively increasing the intraorbital space, reducing orbital pressure, and restoring orbital blood flow.

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OCS is an entirely clinical diagnosis based upon patient history, symptoms, and eye examination findings; no imaging studies or other tests are needed for the diagnosis. An emergency canthotomy and cantholysis cannot be delayed for diagnostic tests, management of non-life-threatening conditions, patient transport to other areas or facilities, or the arrival of an off-site ophthalmologist. Failure to correctly, quickly, effectively, and efficiently perform a canthotomy and cantholysis when an OCS is present will result in a completely blind eye, one which otherwise would have had normal vision.

ORBITAL COMPARTMENT SYNDROME

Recognizing an OCS and performing an effective canthotomy and cantholysis requires a basic understanding of orbital anatomy. The orbit is a space within the bony skull that is shaped like a four-sided pyramid lying on its side. The pyramid's base is the large anterior bony opening surrounding the eye. The apex of the pyramid is the opening where the optic nerve, motor nerves for the extraocular muscles, and orbital blood vessels enter. With the exception of the anterior face of the orbit where the eye is located, the orbit is completely surrounded by bony walls. Anteriorly, the inelastic orbital septum (an extension of the periosteum covering the bony orbital walls) and the eyelids with their tendinous attachments to the bony orbital rims restrict the anterior movement of the eye. Any acute expansion of the orbital soft tissue (e.g., edema, inflammation) or the addition of material to the orbit (e.g., blood, fluid, air, tissue, foreign bodies) increases intraorbital pressure resulting in compression of the orbital vasculature and ischemic injury to the optic nerve and retina. Lacking any capacity to decompress against the bony walls, the eye's only recourse for decompression is anteriorly, even if this direction of movement is limited by the lids and septum. Anterior movement of the eye (clinically termed proptosis or exophthalmos) is necessary to expand the space within the orbit and decrease intraorbital pressure.

The optic nerve and retina are externalized components of the central nervous system (i.e., brain tissue). The optic nerve is an extension of the brain's white matter tracts and the outer portions of the retina contain glial and ganglion cells of the brain's grey matter. Similar to the brain, both the optic nerve and retina are exquisitely sensitive to injury and any interference with their blood supply, and neither can regenerate. Reduction or interruption of blood flow to either the retina or optic nerve is akin to an ischemic stroke, and the result of reduced venous outflow is akin to a hemorrhagic stroke. Reduced or interrupted blood flow to either the optic nerve or retina will lead to irreversible cell death and vision loss.

OCS has multiple underlying causes (Table 1). Trauma-associated orbital hemorrhage is the most common of these and includes both penetrating and blunt trauma. While a lateral canthotomy and lysis of the inferior limb of the lateral canthal tendon will help to lower intraorbital pressure, additional interventions (e.g., removal of an orbital foreign body, steroids, antibiotics, abscess and sinus drainage, vascular embolization, glaucoma medications) should only be carried out by an ophthalmologist. Following canthotomy and cantholysis, patients with an OCS must be urgently transported for evaluation and management by an ophthalmologist. An OCS may not occur immediately after trauma. This is particularly true for burn patients where third spacing of fluid can occur after burn resuscitation. Bleeding from the sinuses or damaged vessels following trauma can restart spontaneously or when a patient "bears down" while going to the bathroom, vomiting, sneezing, nose blowing, weight lifting, bleeding dyscrasias/coagulopathies (e.g., trauma induced coagulopathy) or performing any activity that raises intravascular pressure. Embolized vessels can reopen and rebleed. Patients at high risk for the occurrence or recurrence of an OCS must be closely monitored for its development to avoid any treatment delay.

Table 1 consists of a list of conditions that are associated with the development of an OCS. None of these invariably result in an OCS. All are associated with varying degrees of ocular pain, proptosis, eyelid

TABLE 1. Causes of an orbital compartment syndrome.[1-21]

Causes of an Orbital Compartment Syndrome
Penetrating trauma
Blunt trauma[6]
Acute inflammation (e.g., hyperthyroid disease, idiopathic orbital inflammatory disease)[9,20]
Barotrauma including diving, high altitude activities (e.g., air evacuation, mountain climbing)/intraorbital air (e.g., pneumo-orbita)[21]
High energy blast explosions and industrial accidents involving overpressure waves
Burn resuscitation[15,17]
Traumatic asphyxia
Anticoagulants (e.g., enoxaparin sodium)/coagulopathies (e.g., hereditary coagulopathy, disseminated intravascular coagulation, trauma-induced coagulopathy)
Aspirin or other medications interfering with platelet function
Orbital hemorrhage associated with an A-V malformation or lymphangioma
Active sinus or dental infection
Acute orbital cellulitis
Rapidly enlarging orbital tumors
Prolonged prone position surgery
Vascular abnormalities
Forceful exhalation against resistance (e.g., balloon inflation, holding the nose to clear the ears or sinuses to equalize pressure)/Valsalva maneuver
Vomiting/increased intravascular pressure
Sneezing/nose blowing with intraorbital air (pneumo-orbita/orbital emphysema)[21]
Strangulation
Extravasated radiographic contrast material
Iatrogenic (e.g., retrobulbar injection, eyelid or orbit surgery, post-operative hemorrhaging, sinus surgery)

edema, and decreased ocular motility. It is the sudden onset of painful progressive loss of vision, an afferent pupillary defect (condition in which pupils respond differently to light stimuli), and painful ophthalmoplegia (weakening of the extraocular muscles) that indicates an OCS. Retrobulbar hemorrhage, a vision-threatening condition that results in accumulation of blood behind the eyeball, and OCS can occur in the presence of both orbital fractures and open-globe injury, and can also be a delayed occurrence after both surgery and trauma.

Table 2 consists of characteristic presenting signs, symptoms, and examination findings of an OCS, most of which develop rapidly and require immediate diagnosis and intervention. In addition to the aforementioned conditions, decreased ability to see the color red may also be present in an OCS. Externally, the eyelids may be tense and edematous (Figure 1).

Retrobulbar hemorrhage is associated with periorbital bruising and hemorrhagic chemosis (Figure 2). Eyelid edema caused by inflammation or intraorbital air can interfere with the ability to separate the eyelids and examine the eye. Hemorrhagic or edematous conjunctiva may extrude from between the eyelids or prolapse forward when the eyelids are separated (Figure 2). Ocular motility is reduced and attempts to look in various directions are often accompanied by pain and discomfort. Retrobulbar hemorrhage is associated with an enhanced oculocardiac reflex, which can result in significant and alarming bradycardia.[3] In an OCS, the eye is usually quite firm when gently palpated through the eyelid indicating increased intraocular pressure. There will be significant resistance to retropulsion of the globe indicating increased intraorbital pressure. This can be demonstrated by gently pressing on the eye through the eyelids and comparing the resistance of the involved side with the uninvolved side. The eye should never be palpated or pressed if an open-globe injury is present or suspected. Proptosis (forward protrusion of the globe beyond its normal position) is commonly present with an OCS but may be difficult to evaluate due to the presence of eyelid edema (Figure 1). Looking up at the patient from below ("worm's eye view") or from a view over the forehead ("bird's eye view") may help to determine if an eye is proptotic. If it is possible to view the fundus and optic nerve head with a direct ophthalmoscope, retinal hemorrhages and disc edema are often observed.

Little equipment is needed to perform an emergency examination of a patient with a suspected OCS. The ability to read a nametag or newspaper headlines, to count fingers, or to perceive hand motion or light can be used to grossly determine visual acuity. Ocular motility and pupillary light responses can be checked with a penlight. Any bright red object can be used to determine if there is red color desaturation by asking the patient if the color appears the same in both the uninvolved and involved eye. Red color desaturation indicates involvement of the optic nerve. When it is necessary to

FIGURE 1. Patient with an OCS associated with acute orbital cellulitis and loss of vision. CT image of the same patient showing extreme proptosis with tenting of the posterior globe at the point of optic nerve attachment. (Source: James W. Karesh, MD)

FIGURE 2. Patient with retrobulbar hemorrhage and OCS showing decreased ocular motility, periorbital bruising, hemorrhagic chemosis, and proptosis ("worm's eye view"). (Source: James W. Karesh, MD)

TABLE 2. Signs and Symptoms of an orbital compartment syndrome.[1-21]

Signs of an Orbital Compartment Syndrome
Reduced visual acuity
Proptosis
Resistance to globe retropulsion
Hemorrhage and/or non-hemorrhagic chemosis
Restricted eye movement
Relative afferent pupillary defect
Red color vision desaturation
Increased intraocular pressure
Periorbital and eyelid edema and/or ecchymosis with eyelid ptosis
Optic disc edema or pallor
Retinal edema or hemorrhages
Cherry red macula
Symptoms of an Orbital Compartment Syndrome
Decreased or decreasing vision
Headache
Eye and orbit pain
Double vision
Nausea and vomiting

retract the eyelids to examine the eyes, a large bent paperclip makes an excellent lid retractor. It is usually only possible to estimate intraocular pressure through palpation unless a portable device for measuring intraocular pressure is available. This should only be used if open-globe injury has been ruled out. If a direct ophthalmoscope is available, the fundus and optic nerve head can be assessed. This is often not possible in the deployed situation.

THE LATERAL CANTHOTOMY AND INFERIOR CANTHOLYSIS PROCEDURE

A lateral canthotomy and inferior cantholysis severs the tissues restraining anterior movement of the eye, releasing built-up intraorbital pressure. The importance of performing this procedure correctly cannot be over-emphasized. The eye must be carefully examined after the procedure to ensure that it was performed properly. The canthotomy and cantholysis procedure functions only as a method for reducing intraorbital pressure. Any retrobulbar hemorrhage that is present will not necessarily drain after a canthotomy and cantholysis. The goals of the procedure are to reduce intraorbital pressure, prevent ischemic injury to the optic nerve and retina, and preserve vision until patient care can be handed off to a skilled ophthalmologist.

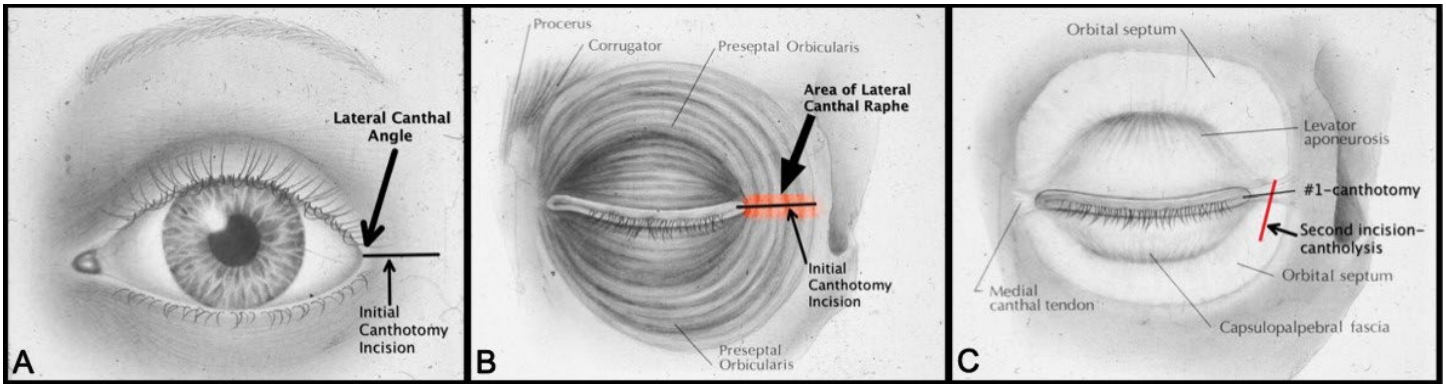
Performing an effective canthotomy and cantholysis requires familiarity with the anatomy of the eyelid (Figures 3A-C). The lateral canthus is the angle created at the point where the upper and lower eyelids join together laterally. The bone of the lateral orbital rim is approximately 1 cm lateral to this point. The inelastic lateral canthal tendon attaches the eyelid to the orbital bone. The orbital septum extends from the orbital rim to merge with the connective tissue of the eyelid. Both the lateral canthal tendon and the septal attachments to the lateral eyelid must be divided to effectively reduce intraorbital pressure. Leaving any of the septal or tendinous attachments of the lateral eyelid intact will prevent the procedure from significantly reducing pressure.

Only a few simple pieces of surgical equipment are necessary to perform a successful canthotomy and cantholysis. Table 3 lists most of the equipment necessary to evaluate visual function before and after canthotomy and cantholysis, and the surgical instruments and medications needed to perform the procedure.

There are several steps involved in performing a successful canthotomy and cantholysis. It is not an easy procedure to perform because of the tense proptosis. Be very careful not to injure the eye and use only **blunt-tipped** scissors to make the cuts. If possible, instill a drop or two of topical ophthalmic anesthetic into the eye to reduce irritation before cleaning and draping the patient. If there is evidence for a fresh facial or orbital surgical procedure where rebleeding might be the cause for the OCS, all sutures from that procedure should be removed and wounds opened. This alone may be sufficient for relieving built-up intraorbital pressure. Subcutaneously inject lidocaine or similar anesthetic across the lateral third of the upper and lower eyelids and into the lateral canthus ballooning up the skin. Begin the injections several millimeters from the eyelid margin and medial to the lateral canthus; direct the injection toward the canthus. Anesthetic with epinephrine is helpful for hemostasis, but it is not necessary. Injections must remain subcutaneous to avoid inadvertent globe injury and perforation. Local subcutaneous anesthesia is preferred over general anesthesia for several reasons; the latter is usually not available outside of a hospital or medical treatment facility and is often associated with nausea, vomiting, and/or "bucking" when awakening, which can worsen retrobulbar hemorrhage. Additionally, the usual time delay for general anesthesia is unwarranted. Canthotomy and cantholysis needs to be performed even if local anesthesia is not fully effective. Ketamine may be a reasonable option in select cases.

After achieving adequate anesthesia, use blunt-tipped scissors to perform the canthotomy by dividing the lateral canthus and lateral canthal tendon into superior and inferior parts (Figure 4A). Optionally, a hemostat can be used to crush the lateral canthal tissues for hemostasis by

FIGURE 3. Left Eye. A. Location of lateral canthal angle (view with skin intact). B. Location of lateral canthal tendon (raphe) and canthotomy incision (skin removed and orbicularis muscle shown). C. Location of canthotomy and cantholysis incision (orbicularis muscle removed showing orbital septum and levator aponeurosis below orbicularis muscle). (Source: James W. Karesh, MD)



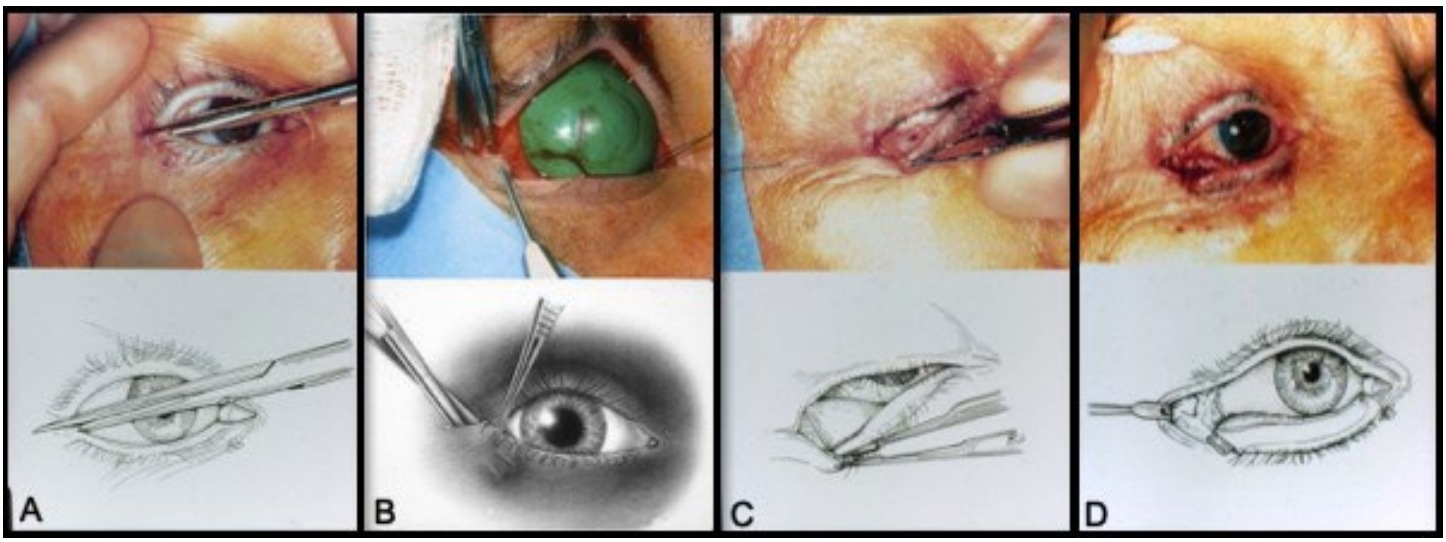


FIGURE 4. Right Eye. A. Performing the lateral canthotomy. B. Dividing the lateral canthal tendon. C. Pulling the lid away from its attachments after cantholysis. D. The appearance of the lid after canthotomy and cantholysis showing it lying away from the globe. (Source: James W. Karesh, MD)

inserting one blade into the lateral conjunctival space posterior to the lateral canthus and the other blade on top of the skin. Close the hemostat and compress the canthus for 15-30 seconds. Remove the hemostat prior to making a canthotomy incision. To perform the canthotomy, position an open scissors so that one blade is behind the canthus and against the lateral orbital rim bone and one blade is on top of the skin. Blunt-tipped scissors are somewhat less apt to cause inadvertent globe damage than sharp-pointed scissors and smaller scissors are generally easier to position and use than larger scissors. The lateral canthal tissue is tough and cannot be easily cut with dull, unsharpened scissors. Straight bladed scissors, such as Metzenbaum or iris scissors are easiest to use. The canthotomy incision should extend through the full-thickness of the lateral canthus, from skin to conjunctiva, for the entire distance between the lateral canthus and the lateral orbital rim. It is important to keep in mind that there are no significant ocular structures that can be damaged by an aggressive lower canthotomy.

The effectiveness of the cantholysis is predicated upon the complete division and release of the canthal tendinous and septal attachments to the lateral lid (Figures 4B-D). To achieve this, the lower lid needs to be placed upon some anterior/outward stretch (toward the ceiling). Using toothed forceps, grasp the lateral lower eyelid slightly medial to where it was attached to the upper eyelid and pull the lid away from the globe. Position the forceps across the eyelid margin grasping the full height of the lower lid (~5 mm), with one arm on the conjunctival surface of the lid and one arm on the skin surface. Grasping the eyelid margin can damage this structure. It may be difficult to grasp the eyelid when tissue edema and proptosis are present. Next, make a 1–2 cm long, full-thickness cut through the tautly stretched tissues lateral to the position of the forceps up to the orbital rim without cutting through the eyelid margin. The incision should be made with one scissor blade inserted into the space between the lid and the eye and the other blade on the skin surface. The scissors' tips should be pointed in the direction of the outer aspect of the nostril or the center of the upper lip. If the cantholysis is successful, the eyelid should snap away from the globe and swing freely. If it seems that the eyelid is still tethered, identify any remaining septal tissues or tendon by pulling the lateral aspect of the lower eyelid superiorly and anteriorly away from the eye and using the tips of the scissors to strum the stretched eyelid tissue. This will help to identify any cord-like attachments still present that need to be cut to detach the lid and complete the cantholysis. Incisional hemorrhage can usually be controlled via direct pressure or gentle cautery (not silver nitrate sticks). A sudden "gush" of blood or fluid from the orbit should not be expected.

Following the procedure, leave the canthotomy and cantholysis incisions open, instill ophthalmic antibiotic ointment onto the area, and tape a rigid shield without a patch over the eye. After the procedure, check visual acuity, pupillary light response, and intraocular pressure to determine if there is any improvement or if additional intervention is required. Vision, pupil response, and resistance to globe retropulsion (the ability to move the eye back into the orbit) should be rechecked at 15-minute intervals. All patients require immediate evacuation for ophthalmologic evaluation following canthotomy and cantholysis, particularly if there is no significant improvement within 30 minutes. During evacuation, coughing, sneezing, vomiting, and other activities that raise intravascular pressure must be controlled to prevent rebleeding. Pain management is important to prevent rebleeding as a result of eye rubbing or lid

Equipment and Medications for Performing a Canthotomy and Cantholysis		
Injectable local anesthetic	Hand sanitizer, cleanser	Tape
3cc or 5cc syringe with 25-gauge needle or smaller	Surgical towels or drapes (optional)	Rigid eye shield
Topical ocular anesthetic drops, if available	Scissors (straight iris, Metzenbaum, or any straight blunt-tipped scissors)	Battery powered hand-held tonometer (e.g., Tono-Pen®) to measure intraocular pressure before and after the procedure (optional)
Ophthalmic antibiotic ointment	Forceps with teeth (micro Adson [preferred], small Adson, other small tissue fixation forceps, or any forceps with teeth)	Hand-held penlight to assess pupillary light response
Alcohol wipe, Betadine (povidone-iodine), or similar surgical site preparation solution	Straight hemostatic clamps/forceps (optional)	Device for quickly checking vision (e.g., fingers, nametag, etc.)
Sterile or examination gloves	4" X 4" or 2" X 2" gauze pads	

TABLE 3. Equipment and medications for performing a canthotomy and cantholysis.

squeezing. Altitude restrictions may be needed when there has been injury to the orbital walls and sinus cavities to account for the possibility of pneumo-orbital compartment syndrome, and to prevent bleeding and pain associated with atmospheric pressure changes. Rebleeding and recurrent OCS are possible even after canthotomy and cantholysis; therefore patients must be regularly checked after surgery and during evacuation for recurrent proptosis, hemorrhage, or decreased vision because additional exploration of the canthotomy site may be necessary. After canthotomy and cantholysis, intravenous acetazolamide or mannitol can be used to further lower intraorbital pressure. The topical ocular pressure lowering drops timolol and brimonidine will also lower intraocular pressure. Intravenous steroids will help to reduce inflammation and should be used in conjunction with intravenous antibiotics for an OCS caused by infectious processes. If necessary, repair of the canthotomy and cantholysis incisions should be delayed for 4–7 days until visual function has stabilized.

Lateral canthotomy and inferior cantholysis is an important emergency procedure to understand and master for preventing irreversible loss of vision from an OCS, particularly for emergency medicine surgeons, trauma surgeons, and forward surgical teams. Additionally, medics who are more likely to encounter an OCS, such as special operations medics, may also benefit from being trained for this procedure. The lateral canthotomy and cantholysis procedure has been incorporated into a number of military training courses, opportunities, and reference materials.[22-34] The 2014 Joint Theater Trauma System Clinical Practice Guideline entitled "The initial care of ocular and adnexal injuries by non-ophthalmologists at role 1, role 2, and non-ophthalmic role 3 facilities" includes the procedure as the recommended treatment for an OCS. Canthotomy and cantholysis has been incorporated into the curriculum of the European Society for Emergency Medicine, the American Board of Emergency Medicine, Emergency Medicine Physician Assistant Postgraduate Training Program Standards, the standard American College of Surgeons Advanced Surgical Skills for Exposure in Trauma course, the Special Operations Combat Medical Skills Sustainment Course, and the Emergency War Surgery Course. In addition, the Army Trauma Training Course, the Center for Sustainment of Trauma and Readiness Skills program, and the Naval Trauma Training Center program have classes covering lateral canthotomy for OCS. Considering the emergency nature of an OCS and the irreversible blindness resulting from a failure to perform a timely, effective, and complete canthotomy and cantholysis, it is recommended that all first responders who encounter severe ocular trauma, whether in peacetime or in combat, receive training in the recognition and initial management of an OCS **[Click to see "Now See This" principles for non-ophthalmic providers]** before transporting patients to an ophthalmologist or provider who is trained to perform an emergency lateral canthotomy and inferior cantholysis. Aeromedical evacuation personnel should also be aware of the signs and symptoms of an OCS such as decreased visual acuity, ocular pain, nausea/vomiting, and headache that may occur during patient transport. In patients with a history of trauma, these symptoms may indicate a reoccurrence of OCS rather than simply being side effects of trauma. Air evacuation should generally be avoided until after the patient has stabilized, however this is often not possible in theater.

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TRAUMA & DAMAGE CONTROL OPHTHALMOLOGY

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Orbital compartment syndrome. (Source: James W. Karesh, MD)

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VISION CENTER OF EXCELLENCE FOCUS ON EMERGENCY OCULAR CARE: ORBITAL COMPARTMENT SYNDROME

Emergency management of ocular trauma is necessary for both the ophthalmic and non-ophthalmic communities. To this end, VCE is sharing quarterly emergency management tips for the non-ophthalmic community as well as Damage Control Ophthalmology (DCO) principles specifically for the ophthalmologist.

In this issue of Frontlines, we share principles for the treatment of Orbital Compartment Syndrome (OCS). OCS is a true ocular emergency that, without immediate intervention, will result in irreversible vision loss. Penetrating and blunt trauma are the most common causes of an OCS, however acute inflammation, barotrauma, and rapid burn resuscitation can also lead to this condition. Contrary to common perception, orbital fracture is not protective of OCS. Ocular pain, proptosis, deteriorating vision, and decreased ocular motility are the most common indications of an OCS. The rapid increase in intraorbital pressure associated with an OCS forces an expansion of the intraorbital contents, thus causing an interruption in blood flow to the optic nerve and retina. Immediate decompression of the orbital compartment is the most effective method of reducing intraorbital pressure and restoring blood flow. This is best achieved by performing a lateral canthotomy and inferior cantholysis within 60–90 minutes of the onset of an OCS [Click to see Feature Article]. A canthotomy and cantholysis should only be performed by an ophthalmologist, or a non-ophthalmic provider who has been previously trained to perform the procedure. However, non-ophthalmic providers who are likely to encounter an OCS (e.g., trauma surgeons, forward surgical teams, special operations medics) cannot delay performing a canthotomy and cantholysis in favor of transferring a patient to an ophthalmologist. The primary objective is to immediately decompress the orbital compartment after OCS and stabilize the patient before initiating transfer.

Further principles regarding combat-related ocular trauma need to be developed and formalized. VCE is currently developing DCO principles, which will encompass the following: *Necessity, Urgency, Adequacy, and Avoidance.*

Necessity - Addresses aspects of care that must be applied at a particular point of care prior to transfer to the next level of care. The need for immediate intervention largely depends on severity of injury.

Urgency - Addresses the time frame in which any necessary treatment or intervention must be performed. Severity of injury will dictate urgency with which the eye must be treated.

Adequacy - Addresses how meticulous or definitive repairs must be. Repairs for severe injuries must be meticulous, where the first repair is typically the final one. However general practitioners and ophthalmologists must also identify injuries for which repairs can be ignored, or be temporized and revised later.

Avoidance - Addresses interventions that should not be performed in order to effectively manage the eye injury.

Emergency Management of Orbital Compartment Syndrome:
For Non-Ophthalmic Providers

PRINCIPLE 1: Perform the ABCs of Eye Trauma to diagnose a patient with an OCS.

- OCS is a clinical diagnosis based on symptoms and eye examination findings. No other imaging studies or diagnostic tests are required
- Measure the patient's **Acuity**. Best measurable visual acuity gives an indication of injury severity; decreased vision may indicate the presence of serious eye injury and a possible OCS. Continue to monitor visual acuity even after canthotomy and cantholysis
- Perform **Best** examination possible of **Both** eyes; restricted ocular motility, proptosis, a tense orbit, and ocular/orbital pain indicate an OCS
- Examine **Contiguous** structures (eye, orbits, and adjacent structures) in patients with head, face, and neck polytrauma. Injuries to these structures may predispose the patient to an OCS, as well as concomitant injuries including open-globe injury, orbital/facial fractures, and periorbital injury. Trauma (blunt and penetrating) to the eye and orbit is the leading cause of OCS
- **DO NOT** perform an ultrasound on an injured eye
- **Evacuate** patient to an ophthalmologist once canthotomy and cantholysis is performed and patient is stabilized. Place **Eye Shield** over the injured eye (See Principle 3). Remove any previously placed lid sutures

PRINCIPLE 2: If an OCS has been diagnosed, immediately perform an emergency lateral canthotomy and inferior cantholysis (only if you have been trained to do so).

- Procedure must be performed within 60–90 minutes of the onset of an OCS. DO NOT delay procedure for diagnostic tests, non-life-threatening injuries, or patient transport
- If available, use local subcutaneous lidocaine for anesthesia. If vision is rapidly decreasing, it may not be possible to use anesthesia in an emergency situation

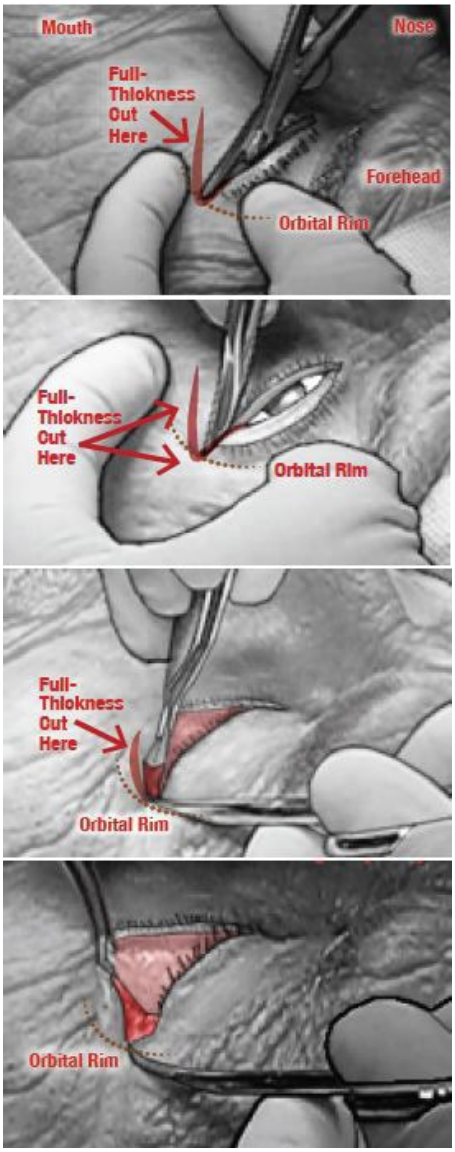
Afferent pupillary defect associated with OCS (Source: American Academy of Ophthalmology)

- Use **blunt-tipped** scissors to avoid injuring the globe
- Horizontal cut: Divide the lateral canthal angle. Full-thickness cut to the rim
- Vertical cut: Divide and release inferior arm of the lateral canthal tendon fully. Full-thickness cut across the lower lid
- Note that there are no critical ocular structures that can be damaged by an aggressive lower canthotomy and cantholysis

PRINCIPLE 3: Evacuate injured patient to the nearest ophthalmologist. Place Eyeshield over the injured eye. SHIELD AND SHIP.

- Do not put pressure of any type on the injured eye after performing canthotomy and cantholysis
- Do not attempt to measure intraocular pressure
- Do not patch the eye
- Place a rigid metal or plastic shield over the injured eye in a way that it does not touch the eye. Hold the shield in place with tape
- Eye protection (APEL/MCEP), goggles, glasses, or a Styrofoam or paper cup can be used as temporary shields
- Evacuate (ship) casualty expeditiously to the nearest ophthalmologist. Note that patients with concomitant orbital and/or facial fractures may also need to be evaluated by neurosurgeons and otolaryngologists
- Monitor visual acuity en route for possible reoccurrence of OCS

Individual with an OCS demonstrating proptosis being evaluated via the "worm's eye" view. (Source: James W. Karesh, MD)



Steps for performing a lateral canthotomy and inferior cantholysis. (Source: James W. Karesh, MD)

continued from page 9

Damage Control Ophthalmology: For Ophthalmologists

DCO PRINCIPLE 1: Perform emergency lateral canthotomy and inferior cantholysis if an OCS has been diagnosed.

- When an OCS is present, an emergency canthotomy and cantholysis must be performed even if there is an open-globe injury
- If an OCS occurs after eyelid surgery or orbital surgery, remove all sutures from the surgical incision to permit release of any built-up post-operative hemorrhage
- Canthotomy and cantholysis procedure must be carried out within 60–90 minutes of the onset of an OCS
- DO NOT delay procedure for diagnostic tests, non-life-threatening injuries, or patient transport. Remember, the diagnosis of an OCS is based entirely on clinical findings
- If available, use local subcutaneous lidocaine for anesthesia. If vision is rapidly decreasing, it may not be possible to use anesthesia in an emergency situation

+ **Necessity** – Critical
+ **Urgency** – Immediate, within 60–90 minutes
+ **Adequacy** – Ensure complete cantholysis
+ **Avoidance** – N/A

DCO PRINCIPLE 2: If the initial canthotomy and cantholysis of the inferior limb of the lateral canthal tendon fails to improve vision, lower intraocular pressure, or reduce intraorbital pressure (improve globe retropulsion), the following additional steps can be taken:

- First, perform a cantholysis of the superior limb of the lateral canthal tendon. Incising the lacrimal gland and lacrimal ductules should be avoided, if possible. Identify the tendon by strumming it with the tips of the scissors before dividing it
- Second, using a hemostat or blunt-tipped scissors, open the intramuscular septum by bluntly dissecting between the lateral and inferior rectus muscles to enter the intraconal/central surgical space and allow fat and hemorrhage to expand anteriorly
- Third, using a hemostat, infracture the floor of the orbit. This is only effective if the orbital septum has been sufficiently opened to permit the orbital fat and any associated hemorrhage to herniate into the maxillary sinus

+ **Necessity** – Critical
+ **Urgency** – Immediately, if no improvement is observed 30 minutes after initial canthotomy and cantholysis
+ **Adequacy** – Effective decompression can be determined by noting an improvement in vision, red color desaturation, the pupil's response to light, a reduction in an afferent pupillary defect, a reduction in intraocular pressure, improvement in globe retropulsion, or a reduction in palpable orbital pressure. Do not sacrifice whatever it takes to achieve an effective resolution of an OCS for the sake of cosmetics
+ **Avoidance** – N/A

DCO PRINCIPLE 3: If orbital pressure still seems high after canthotomy and cantholysis and other surgical maneuvers, various pressure lowering drugs may be helpful, including IV mannitol, PO glycerin, and IV acetazolamide. These drugs should only be used as supplemental treatments and are not substitutes for canthotomy and cantholysis.

+ **Necessity** – Critical, as an adjunct to canthotomy and cantholysis
+ **Urgency** – As soon as possible
+ **Adequacy** – Mannitol: 0.25–2 g/kg IV
  Glycerin: 1–2 g/kg PO
  Acetazolamide: 500 mg q12h IV
+ **Avoidance** – If not contraindicated by systemic status

DCO PRINCIPLE 4: There are many causes for an OCS besides intraorbital hemorrhage. Other causes include orbital cellulitis and abscess, orbital inflammation, retained orbital air, and retained orbital foreign bodies.

- Perform a CT if orbital cellulitis is suspected. Determine if a sinus infection or an orbital abscess is also present. Obtain an ENT consult for possible sinus drainage. Examine the mouth and skin for infection. Surgically drain any orbital abscess. Use IV antibiotics effective against both gram-negative and gram-positive organisms. OCS treatment usually requires hospitalization
- Suggested treatment for adults with orbital cellulitis includes nasal decongestants, IV cefazolin 500-1000 mg q6-8hr or clindamycin 600-2700 mg/day q6-12hr or cefuroxime 750-1500 q6-8hr and metronidazole 500 mg q6-8hr
- When an abscess or a sinus has been drained, a drain (e.g., Penrose or rubber drain) should be placed in the abscess space to prevent re-accumulation of the abscess
- While inserting a needle into the orbit to drain trapped air (pneumo-orbita) causing an OCS is generally not recommended, there may be rare occassions when it is necessary. Usually a canthotomy and cantholysis with opening of the orbital septum is sufficient to release trapped air causing an OCS. When pneumo-orbita is present, patients should be cautioned not to blow their nose. Personnel involved in the air evacuation of patients should be aware that pneumo-orbita can occur, or worsen, due to changes in altitude and cabin pressure as well as sino-orbital communication and fractures

+ **Necessity** – Critical
+ **Urgency** – Immediately if an infection is present
+ **Adequacy** – Meticulous
+ **Avoidance** – N/A

DCO PRINCIPLE 5: Vision, pupillary response, red color desaturation, reduction in intraocular pressure, and resistance to globe retropulsion should be rechecked at 15-minute intervals.

+ **Necessity** – Critical
+ **Urgency** – Every 15 minutes after canthotomy and cantholysis
+ **Adequacy** – Comprehensive
+ **Avoidance** – Ensure patient is stable prior to transfer to avoid risk of OCS reoccurrence

Conference Presentations and Publications

The following presentations and publications highlight contributions from VCE staff and collaborators.

Recent Conferences

American Academy of Ophthalmology 2017

11–14 November 2017, Ernest N. Morial Convention Center, New Orleans, LA | https://aao.org

Symposium

World War I to Now: The Evolution of Combat Eye Care and Rehabilitation in the DoD and VA Across 100 Years of Conflict

Robert A. Mazzoli, MD, FACS, COL (Ret) MC USA; Glenn Cockerham, MD, Col (Ret) MC USAF

Podium Presentations

Periorbital and Orbital Trauma

Robert A. Mazzoli, MD, FACS

Military and Combat Casualty Care

Robert A. Mazzoli, MD, FACS; Marcus H. Colyer, MD; Mark F. Torres, MD; Jonathan Ellis, MD; Gary Legault, MD; Yoshihiro Yonekawa, MD

AMSUS: The Society of Federal Health Professionals

28 November–1 December 2017, Gaylord National Resort & Convention Center, National Harbor, MD | www.amsus.org

Presentations

Managing Ocularmotor Dysfunctions after Traumatic Brain Injury (TBI) – A Clinical Recommendation

Felix Barker, OD, MS

American Society of Ophthalmic Plastic and Reconstructive Surgery

9–10 November 2017, Hyatt Regency, New Orleans, LA | https://www.asoprs.org/

Upcoming Conferences

2017 International Blast Injury State of the Science Meeting - The Neurological Effects of Repeated Exposure to Military Occupational Blast: Implications for Prevention and Health

23–25 January 2018, RAND Pentagon City Office, Arlington, VA | https://blastinjuryresearch.amedd.army.mil/

National Capital Area TBI Research Symposium 2018

6–7 March 2018, Natcher Conference Center, National Institutes of Health, Bethesda, MD | https://hjf.cvent.com/events/national-capital-area-tbi-research-symposium-2018

Presentations

Visual Rehabilitation Following Traumatic Brain Injury (TBI): TBI Consensus Statement Project 2017

Felix Barker II, OD, MS; Natalya Merezhinskaya, PhD; Geeta Girdher, OD; Suzanne Wickum, OD; Marcy Pape, MPT; Paul Koons, MS, CLVT, CBIS; Bre Myers, AuD, PhD; Lynn Greenspan, OD, PhD; Thomas Ableman, MD

The Association for Research in Vision and Ophthalmology (ARVO)

29 April–3 May 2018, Hawaii Convention Center, Honolulu, HI | https://www.arvo.org/

Recent Publications

Reynolds ME, Hoover C, Riesberg JC, Mazzoli RA, Colyer MH, Barnes S, Calvano CJ, Karesh JW, Murray CK, Butler FK, Keenan S, Shackelford S. **Evaluation and Treatment of Ocular Injuries and Vision-Threatening Conditions in Prolonged Field Care**. *Journal of Special Operations Medicine*. 2017;17(4):115-126.

Calvano CJ, Enzenauer RW, Eisnor DL, Mazzoli RA. **Atropine Eye Drops: A Proposed Field Expedient Substitute in the Absence of Atropine Autoinjectors.** *Journal of Special Operations Medicine*. 2017;17(3):81-83.