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International Commission for Alpine Rescue
Commission for Mountain Emergency Medicine (ICAR MEDCOM)

EYE PROBLEMS IN MOUNTAIN AND REMOTE AREAS: PREVENTION AND ON SITE TREATMENT

Intended for first responders, physicians, paramedics and mountaineers

OFFICIAL RECOMMENDATION OF THE INTERNATIONAL COMMISSION FOR MOUNTAIN EMERGENCY MEDICINE (ICAR MEDCOM)

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Running head: Eye problems in the mountains

This article reflects the consensus of opinion of the International Commission for Mountain Emergency Medicine, which has full responsibility for the content.

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ABSTRACT

Although eyes are not frequently injured in the mountains, they are exposed to many adverse factors from the environment. This review article, intended for first responders, physicians, paramedics and mountaineers, was compiled following a Medline search of the literature supplemented by reading standard mountain medicine texts. Cited articles were chosen as being most applicable for the wilderness environment. The draft was then discussed amongst the International Commission for Mountain Emergency Medicine (ICAR-MEDCOM) members and a consensus document developed. Its aim is to give practical advice on the management of eye problems in mountainous and remote areas. Snow blindness and minor injuries such as conjunctival or corneal foreign bodies could immobilize a person and put them at risk of other injuries. Blunt or penetrating trauma can result in the loss of sight in the eye; this may be preventable if the injury is managed properly. In almost all cases of the severe eye trauma, protecting the eye and arranging an immediate evacuation is necessary. The most common eye problems, however, are due to UV light and high altitude. People wearing contact lenses and with previous history of eye diseases are more vulnerable. Eye problems induced by high altitude should be managed using the same principles as other high altitude illnesses. Wearing appropriate eye protection, such as sunglasses or goggles with polarized or photochromic lenses, could prevent most of the common eye problems in mountaineering.

KEYWORDS

Altitude, Eye injuries, Mountaineering, Mountain emergency medicine, Ultraviolet Rays

INTRODUCTION

In the mountain or wilderness environment, even minor injuries or visual disturbance could immobilize a person or make them dependant on other members of their party. This could precipitate other problems, such as a slow descent and unplanned bivouacs, thus putting the person and their party at risk. In this review, we focus on the most common eye problems seen in the mountains. Our aim is to give first responders, physicians, paramedics and mountaineers practical advice on the prevention and safe management of these problems particularly where timely specialist help is not available.

Although the eye surface area is less than 0.1 % of the total body surface, and therefore infrequently injured, eye injuries related to outdoor and sport activities in the mountains and wilderness areas are common. Most are minor eye injuries. (1) However, unrecognized, or poorly treated, injuries can lead to a permanent and severe visual impairment. In addition, many noxious factors in the environment are magnified in the mountains, and expose mountaineers and local inhabitants to an increased risk of eye problems. Undergoing corneal refractory surgery or wearing contact lenses have implications to a person venturing into the wilderness if the convenience gained is not to be lost. These factors are listed in Table 1.

SPECIFIC EYE CONDITIONS IN MOUNTAIN AND REMOTE AREAS

UV light problems

Ultraviolet light is a non-ionizing radiation and is divided into UV-A (315 to 400 nm), UV-B (280 to 314 nm), and UV-C (180 to 280 nm). The Earth's atmosphere absorbs all UV-C radiation and more than 99% of UV-B radiation. It is known that the quantity of UV light increases with increasing altitude at a rate of 4% for each 300 m ascent), low latitude, and in highly reflective environments. For example, the reflection of ultraviolet increases two times from the surface of water and eight times from snow when compared to the reflection from a field of grass. (2) The combination of altitude and snow at 2000 m results in a doubling of the quantity of UV light compared to sea level; damage to almost all eye tissues (eye lids, cornea, conjunctiva and lens) could occur. (3)

Acute exposure damages the conjunctiva and cornea causing snow blindness. Symptoms range from mild irritation and a foreign body sensation to severe pain, light sensitivity (photophobia),

lid spasm and watering. The discomfort starts 4 to 10 hours after exposure, so often during the following night. The condition abates 12 to 48 hours later though sometimes, in severe cases, it can last several days. (4)

Long-term exposure to UV light is associated with conjunctival degenerations (pinguecula and pterygia) but not corneal damage. (5) The incidence of cataract is higher in populations that have a higher cumulative exposure to UV light. (3) Recent data has suggested that short-wavelength visible (blue) light has a damaging effect on the region of greatest visual acuity (macula) and is a risk factor for macular degeneration. (6,7) However other studies have not confirmed the association. (8,9)

High altitude eye problems

Disturbance in visual function can result from the hypoxia of altitude and the effects of cold. Hypoxia and a drying effect on the cornea from the increased evaporation of the tears, especially in windy conditions, can cause corneal swelling (edema). In normal eyes, this usually causes no visual disturbance though after corneal refractory surgery, refractory changes can occur (see below).

High altitude and hypoxia also affect the retina. Retinal hemorrhage is common but usually asymptomatic. However, if the macula is involved severe visual difficulties can occur. (10) The cause of retinal hemorrhage and its relationship to other attitude illnesses particularly Acute Mountain Sickness is unclear. A single case report of bilateral retinal detachment in a trekker with multiple pre-existing risk factors has been described. (11)

In addition, transient monocular blindness (amaurosis fugax) and binocular brain cortex (cortical) blindness have been described. Both seem to resolve spontaneously and are thought to be the result of vascular spasm (ischemia) of the retinal artery and cerebral blood vessels supplying the visual cortex respectively. (12)

Although rare, freezing of the eyelid and cornea may occur at high altitude or during a blizzard. The condition hampers navigation and is painful but without permanent damage. More commonly, fogging of glasses can be a real problem, especially when supplementary oxygen is being used.

Contact lenses problems

Contact lenses may be used successfully in the mountains and at high altitude. (13) However, the wearer has to be cautious and pay particular attention to cleaning the lens and avoiding eye infections. Contact lens wearers often note that their eyes become dry or irritated. This discomfort may be solved the more frequent use of rewetting drops though this may not always be practical, Even those contact lenses with a high oxygen permeability, decrease the oxygen delivery to the cornea. *Extended-wear* contact lenses are associated with an increased risk of corneal infections. Therefore, the overnight use of *extended-wear* contact lenses should be avoided at the first sign of discomfort or if conditions do not allow their removal, as they are associated with an increased risk of corneal infections. UV light absorbing contact lenses protect the cornea and deeper eye structures. However, the conjunctiva and eyelids are not protected. Contact lenses in a case filled with liquid solution, as well as cleaning solutions and rewetting drops can freeze at night in cold weather.

Eye problems associated with history of eye disease or surgery

Mader and Tabin have extensively reviewed the literature on mountaineers with preexisting eye problems venturing to altitude, and the reader is referred to their paper for greater detail. (13)

Persons who have had corneal refractory surgery and then go to altitude or into a cold, dry environment, such as the polar regions, may develop blurred vision as a consequence of a refractory change. The problem can occur with most of the common surgical techniques but seems more prevalent when a patient has had a radial keratotomy, where radial cuts are made in the cornea, and then goes to altitude. The hypoxia-induced corneal edema makes the person become far-sighted; this is of nuisance value at moderate altitude making map reading difficult but at extreme altitude can lead to near blindness with severe consequences. Unfortunately the degree of refractory change cannot be predicted so a series of ‘reading glasses’ may need to be taken to counter the effect. (14) Following bilateral laser in situ keratomileusis (LASIK), an opposite (myopic) temporary refractory shift has been reported in two climbers going to altitude (6959m) and a patient who trekked to the North Pole. (15, 16) These patients were in the ‘post operative’ period (less than four months) from surgery and it is unclear whether the refractory changes would occur after the surgery has fully matured (greater than 6 months). The change was thought to be due to hypoxia in the case of altitude and a drying of the cornea at the North

Pole. Previous retinal detachment surgery that leaves intraocular gas in the globe is a contraindication to ascending to altitude as the risk of expansion of the gas bubble can threaten irreversible loss of vision.

EYE INJURIES

Minor injuries of the eye, such as corneal erosions or small corneal surface or conjunctival foreign bodies, can be caused by particles blown into the eye by a strong wind, during hammering or ice axe placement. Contact lens use can also lead to corneal erosion. Most small corneal erosions will heal after 24 -36 hours as well as those left after the extraction of a small foreign body. However, corneal erosions can, rarely, become to infected and create an ulcer, so proper recognition and treatment is necessary.

Blunt or penetrating eye trauma with globe rupture may not always be obvious, but threatens loss of vision and even the eye.

Symptoms and examination

A complaint of blurred vision, eye irritation or injury should result in a careful inspection. Inspect both eyes and compare them. A penlight will be helpful for examination. Ask about recent exposure to potential trauma.

Pain, a 'red eye', light sensitivity and lid spasm are the commonest symptoms of eye trauma and/or infection. If the person complains of discomfort or pain in the eye after exposure to a strong wind, suspect an erosion or corneal/conjunctival foreign body. The sensation of *'something in the eye'* does not necessarily mean that a conjunctival or corneal foreign body is present. Definitive diagnosis requires the visualization of the foreign body, but sometimes this can be difficult. A common position for a foreign body is under the upper lid; lay persons going to remote areas should learn the technique for everting the lid. Eyelid trauma should be examined carefully to exclude the presence of a penetrating injury of the eye globe or orbit.

After blunt trauma to the eye or injury from a tree branch, the eye must be examined. Eyes suffering from severe blunt trauma and/or penetration usually have poor vision and pain; compare it with the uninjured eye. Try to exclude a penetrating injury by careful examination but minimize the manipulation of an injured eye. In case of an obviously ruptured eye the

examination should be discontinued. The practical procedure for eye examination is shown in Table 2.

Presence of blood behind the cornea that obscures the pupil (hyphema) or a large conjunctival hemorrhage with conjunctival edema indicate severe blunt trauma. A very soft eye (hypotony) is likely to be ruptured. Signs of an occult rupture include a large subconjunctival hemorrhage with conjunctival oedema; dark uveal tissue at the corneal margin (limbus) and an irregular shaped pupil. Blood under the “white of the eye” without pain and without changes to the cornea or iris in an eye with normal vision is not a serious sign.

Treatment

General considerations

Most symptomatic eyes may be covered with soft dressing if practical. Sunglasses and goggles over the dressing can be helpful. However, try not to cover eyes with minor corneal abrasions as patching does not improve healing nor reduce pain and prevents binocular vision. (17) Topical eye anesthetics delay corneal healing. Therefore, they should only be used in extreme situations to control disabling symptoms. In such cases, systemic pain killers (analgesics) tend to help. An urgent evacuation is necessary in cases of a penetrated or ruptured eye; when blunt trauma has decreased the vision or when a severe lid laceration is present.

Snow blindness

Calm the person and ask them to close both eyes and rest until the discomfort regresses. Give non-steroid anti-inflammatory eye drops, such as diclofenac 0.1%, and, if necessary, analgesics such as paracetamol (acetaminophen). Cooling through the closed eyelids may reduce discomfort and, of course, it’s obligatory to wear sunglasses afterwards to prevent a recurrence.

Corneal erosions, with or without small foreign bodies

Try to wash out the foreign body with tears, clean water and movements of the eyeball. If unsuccessful, try to remove the foreign body gently with a cotton-tipped swab or with gauze. The routine use of antibiotic drops or ointment, such as bacitracin, tobramycin, or ciprofloxacin, after the removal of a foreign body is not required. (18) However erosions secondary to contact lens should have a topical wide-spectrum antibiotic applied as prophylaxis against pseudomonas infection. (19) Erosions at very high altitude are treated likewise. Rest the eye by closing both eyes for a short time. Systemic analgesics and/or non-steroid anti-inflammatory eye

drops can be used if the discomfort persists. (20,21) The latter, though expensive, may reduce the need for sedative oral analgesia and thus allow the person to remain mobile. (22) Wear sunglasses afterwards.

Suspected or obvious penetration of the eye and severe blunt trauma or globe rupture

A suspected penetrating injury should be treated as if present. Do not use any topical preparations and, if possible, try not to take out a foreign body that has ruptured the eye. Close the eye carefully; place a soft dressing over it without applying pressure and use a protective shield or goggles to prevent any inadvertent pressure during the evacuation. Paracetamol (acetaminophen) tablets may not be strong enough to relieve the pain; stronger analgesics can be given if appropriate. Systemic antibiotics, such as ciprofloxacin should be started as soon as possible and an immediately evacuation arranged, using a helicopter if available. Ideally, an eye specialist in hospital should treat a lid laceration that penetrates the full thickness of the lid or involves the lid margin. Other lid lacerations can be managed as uncomplicated surface wounds.

HIGH ALTITUDE EYE PROBLEMS

Reduced vision at high altitude can present a serious risk to the patient and have consequences to the rest of the party. **Descent** is recommended. In the presence of high altitude illness follow the UIAA guidelines. (23) There is uncertainty whether descent is required in persons with asymptomatic retinal hemorrhage as many resolve without detriment. However, other risk factors such as monocular vision and the presence of other high altitude illness may prompt descent.

If contact lens wearers develop any eye symptoms, the lens should be removed and lubricating drops applied. Antibiotic eye drops or ointment should be applied immediately if symptoms continue. If, despite antibiotics, the eye does rapidly improve over 48 hours, descent and a different topical antibiotic should be considered.

PREVENTION OF EYE PROBLEMS

Wear protective glasses of polycarbonate with side shields or adequate eye protection in the form of goggles whenever there is a risk of eye trauma. It is obligatory for all persons in snowy and mountainous conditions to wear high quality sunglasses made that absorb all UV radiation.

(24) Hats with a shield can also increase comfort levels. Don't forget that children's eyes are particularly sensitive to UV light. Ski goggles are often more practical and comfortable at high altitude or in windy conditions. Fogging can be problematic particularly when supplementary oxygen is used; ventilated goggles can effectively reduce this. Working near helicopters, where the turbulent air is often filled with foreign bodies, is a risky environment. Goggles are particularly recommended for rescue personnel.

Contact lens wearers should carefully plan their mountaineering and be prepared to deal with the problems described above. They have to be cautious and pay particular attention to cleaning the lens and avoiding eye infections. To avoid dry or irritated eyes rewetting drops should be used frequently though this may not always be practical. The overnight use of *extended-wear* contact lenses should be avoided at the first sign of discomfort or if conditions do not allow their removal. Contact lenses in a case filled with liquid solution, as cleaning solutions and rewetting drops, should be kept warm inside a sleeping bag.

Nonprescription protective sunglasses or ski goggles will be required as well as backup refractive glasses and sunglasses whenever the person is in a mountain or wilderness area. A contact lens can easily be lost or an eye can become red or painful. Both antibiotic eye drops and contact lens rewetting drops should be carried.

Persons going to very high altitude (over 3500m or 11,483 ft) or into remote areas who have a previous history of eye disease especially inflammations or infections, such as uveitis and herpetic keratitis, should consult their eye specialist and take appropriate prescribed medication with them in case they suffer a recurrence of the disease. Having the correct medications and knowledge to use them can avoid many problems. Persons with previous retinal detachment surgery should consult their eye surgeon about their activity in mountains. In addition, Morris et al. advise that all high myopes (persons that need thick lenses to see distant objects) going to very high altitude undergo a full prophylactic retinal examination for risk factors of detachment. (11)

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TABLE 1: Risk Factors

– Ultra Violet Ray exposure
– Strong wind and small flying particles (ice, sand, etc.)
– High altitude and hypoxia
– Cold and dry conditions
– Activity during the night, and in woods and bushes
– Wearing contact lenses
– Previous history of eye problems (uveitis and herpetic keratitis, retinal detachment and ocular surgery)
– Only one functional eye

TABLE 2: Procedure for a practical eye examination.

– Calm the person and ask them to slowly open the eyes
– Inspect the eyelids and surrounding areas
– Check the conjunctiva by pulling the lower lid gently down
– Check the cornea
– Check the iris and pupil
– Check movements of the eyeball
– Ask the person about their vision. Test the vision in each eye separately. Cover first one and then the other eye and compare the vision
– Remove contact lenses, if possible
– If the person continues to complain of sensation of a foreign body, try to evert upper lid with the cotton - tipped stick and inspect inner surface of the upper eyelid