Sports-Related Eye Injuries

"It's not macho!" "It's not my style!" These were comments made by two professional athletes when urged to don protective eyewear following potentially career threatening eye injuries. One was diagnosed as having a traumatic hyphema and the other a traumatic optic neuropathy. Although we see more athletes wearing protective eyewear while participating in sports today, there remains the stigma of "weakness" when wearing goggles or a shield. Another professional athlete claimed, after sustaining a serious eye injury, "that I haven't had an eye injury in 20 years and I don't expect to have another for 20 more years."

In 1994 there were an estimated 43,659 sports and recreational product-related eye injuries treated in hospital emergency rooms (United States Consumer Product Safety Commission). This estimate did not include athletes who had sustained a sports-related eye injury and were subsequently examined by their personal physician, therefore, the number was undoubtedly greatly under estimated. In 1985 there were an estimated 32,433 injuries; the increase may be due to more athletes participating in sports or better data collection. In either case the medical and coaching professions must be more diligent in recommending adequate sports eye protection for athletes, especially those at risk.

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Table 1

Highest Eye Injury Frequency by Sport

1994*	1985*
Basketball=9,117 (20.9%)	Baseball=5,977
Baseball=6,907 (15.8%)	Basketball=5,510
Pool Activities=4,039 (9.3%)	Racquet Sports=1,994

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Table 2

Sports With Highest Frequency of Eye Injury by Age Group

1994*	1985*
5-14 years old:	5-14 years old:
Baseball=3,460 (20.7%)	Baseball=2,865
Basketball=2,727 (16.2%)	Basketball=1,137
Pool Activities=1,687 (10.1%)	Soccer=673
15-24 years old:	15-24 years old:
Basketball=3,774 (32.4%)	Basketball=2,777
Baseball=1,736 (14.9%)	Baseball=1,619
Football=1,066 (9.1%)	Football=1,005
25-64 years old:	25-64 years old
Basketball=2,626 (21.1%)	Basketball=1,596
Pool Activities=1,545 (12.4%)	Racquetball=1,574
Baseball=1,489 (12.0%)	Baseball=1,339

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Mechanism of Eye Injury

Sports-related eye injuries may be blunt or sharp in nature. The most common cause of a sharp injury which would result in a penetration or perforation injury of the globe would be the shattering of a spectacle lens (inappropriate for sport). Another etiology of a sharp injury would be a fingernail being forcefully poked into an eye while playing basketball.

The majority of sports-related eye injuries are of a blunt nature and more commonly result in edema and ecchymosis of the eyelids, orbital fracture, corneal abrasion, traumatic iritis, traumatic hyphema, or commotio retinae. Frequently the result of the injury is a combination of these conditions.

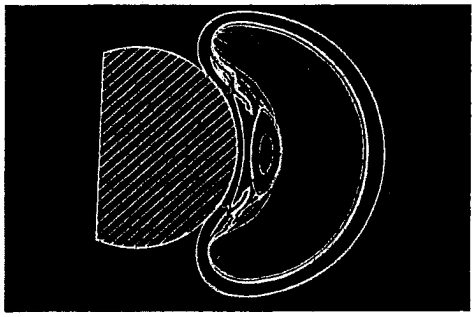


Figure 1: Ball impacting cornea—endothelial surface of cornea striking iris-lens diaphragm. *(Acknowledgement: Eye Trauma. Mosby Year Book, Inc., 1991.)*

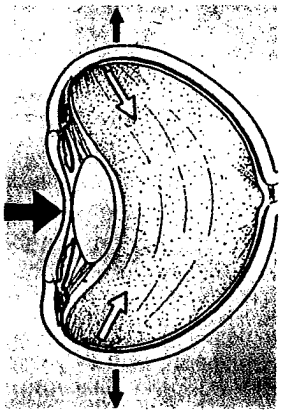


Figure 2: Impact same as figure 1—arrows showing forces. *(Acknowledgement: Eye Trauma. Mosby Year Book, Inc., 1991.)*

When a globe is impacted with a blunt object there is a sudden decrease in anterior-posterior diameter, an increase in the equatorial diameter, a shock wave traverses the globe and the intraorbital pressure is elevated (Figures 1 and 2, previous page). This distortion of the globe may result in the tearing of ocular tissues, often involving blood vessels (Figure 3). When vascular tissue is involved, bleeding occurs either in the lids, orbit, subconjunctival area, anterior chamber, vitreous cavity, intraretinal tissue, and/or in the optic nerve sheath.

Because of the increase in the intraorbital pressure the thinner walls of the orbit such as the floor or medial wall may fracture ("blowout") (Figure 4). Another mechanism which may result in a floor fracture is a severe impact on the inferior rim of the orbit which may result in buckling of the floor (Figure 5). When orbital bones are fractured,

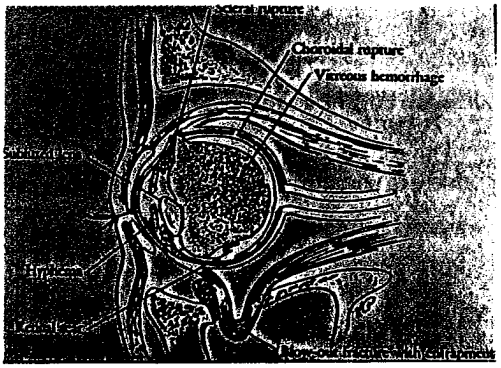


Figure 3: Diagram showing variety of eye/orbital conditions resulting from impact.

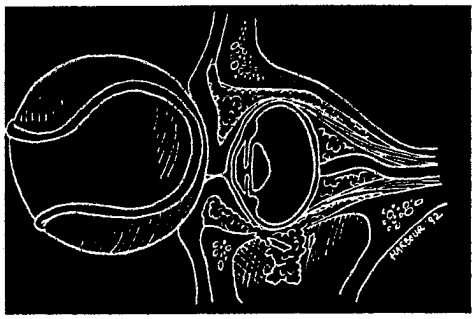


Figure 4: Ball impacting orbit and globe; decreased AP diameter, increased equatorial diameter, increased intraorbital pressure=floor fracture.

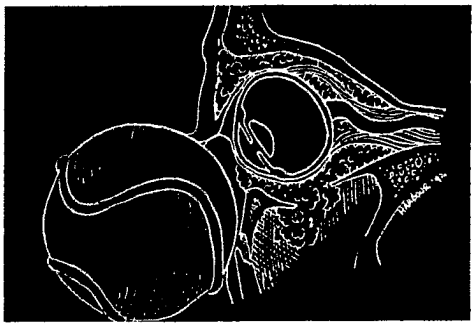


Figure 5: Ball impacting inferior orbital rim causing buckling=floor fracture.

Figure 6: Orbital blunt trauma from baseball pitching machine resulting in fracture. Note limited upgaze of left eye.

Figure 7: CT scan of patient in Figure 6 demonstrating left tripod fracture.

extraocular tissues inferior to the globe may become entrapped or the orbital fat may sink into a large fracture site, resulting in enophthalmus. Diplopia is manifested by entrapment (Figures 6 and 7). Multiple bones may be involved as with a tripod fracture following high energy impacts.

Sports-Related Eye Injury Risk

Sports-related injuries are traditionally categorized as occurring in a contact (collision) or non-contact event; this classification is not appropriate when considering injuries to the eye. For instance, racquetball or squash are non-contact sports but they are played in a very confined space, resulting in close encounters. When participants are wielding a racquet to hit a fast moving missile, the risk of a potentially devastating eye injury is ever present. Eye injuries are therefore better classified as low eye-risk, high

Table 3

Relative Eye Injury Risk

Low eye-risk sports: Sports that do not involve a thrown or hit ball, a stick or bat, or close aggressive play, therefore having a low incidence of eye injuries. These sports would include track and field, cross country, swimming, gymnastics, and cycling.

High eye-risk sports: There is a direct relationship between the use of a stick or racquet (hockey, lacrosse, racquet sports), high speed balls (baseball, racquet sports, soccer), close aggressive play (basketball, football) and potentially serious eye injuries. These sports can be eye-safe, even for the one-eyed athlete, if appropriate, properly fitted protective devices are worn.

High eye-risk sports with no available eye protectors: Adequate eye protection is either not available or not practical for use in boxing, wrestling, and full contact martial arts.

Table 4

Danger Signs and Symptoms Following An Eye Injury

Decrease or loss of vision
Limitation of eye movement
"Flashing lights" with onset of "floating specks or cobwebs"
Pain in the eye (with/without movement)
Partial or complete loss of field of vision
Protrusion of one eye
Photophobia (may be immediate or delayed)
Blood in the anterior chamber
Diplopia (binocular vs. monocular or "ghost image"*)
Irregularly shaped pupil
Foreign body sensation
Obvious laceration of ocular tissue
"Red Eye"

*"Ghost image" may be perceived as diplopia in one eye. This is comparable to the TV "ghost image." Usually it is secondary to a refractive error (especially astigmatism) or abnormal tear film.

eye-risk, or high eye-risk without available eye protection.

On-Field or on-Court Evaluation of an Athlete with an Injured Eye

Familiarity with the pertinent past ocular history is essential. Ideally a preparticipation visual screening has been included in the general physical evaluation. It is useful to have knowledge pertaining to needed refractive error correction (glasses or contact lenses), history of amblyopia, past ocular trauma, previous intraocular or keratorefractive surgery, or any potentially serious or recurrent eye disease.

As a comprehensive ophthalmologist or primary care physician, the necessary components for the evaluation of an acute eye injury should include the following:

- Obtain brief history of etiologic agent, along with direction and relative energy of impact (ie baseball: line drive vs. "bad hop").
- Obtain a reproducible visual acuity (type or size of object of regard and from what distance?) by near vision card, count fingers, hand motions or with or without perception of light.
- Topical anesthestic instillation may offer pain relief to obtain better responses.
- Check eye movements (limitation), pupillary response (afferent pupillary defect), and palpate for bony deformities and hypesthesia. Determine if player is clear to resume play.
- Instill no additional medication (especially ointment) unless certain there is no ruptured globe.
- If ruptured globe is suspected—shield eye.
- Determine need for further exam with more sophisticated equipment, imaging (ultrasound, CT, MRI), extensive treatment or hospitalization.

The Functionally One-Eyed Athlete

Special attention must be directed to the functionally one-eyed athlete. An athlete is considered to be functionally one-eyed if the poorer seeing eye is worse than 20/40 (best corrected) vision and the other eye corrects to 20/40 or better. If the better seeing eye is damaged as a result of a serious sports-related injury there would be a significant change in the athlete's lifestyle (driving,* sports/ recreational activities, occupational endeavors).

Such an athlete need not be prevented from participating in all sports. He/she may participate in many sports as long as the appropriate, well-fitted protective eyewear is worn (with or without a helmet). The only exceptions would be participating in boxing, wrestling or full contact martial arts.

The most common cause of functionally one-eyed patients is amblyopia; prior eye injury, intraocular or keratorefractive surgery, or serious eye disease account for the others.

The decision for the functionally one-eyed athlete to participate in any sport must be considered on an individual basis. A waiver may need to be created but would probably be of little value in the event of a devastating eye injury. Therefore, it is the responsibility of eye care physicians and primary care physicians to strongly recommend the wearing of polycarbonate protective eyewear all waking hours and sport-specific appropriate polycarbonate protection when involved in athletic events. The physician *must* document such recommendations in the patient's chart.

Eye Protection for Sports

Proper fitting of sports goggles is necessary for comfortable wear and should be measured and fit by an experienced optometrist or optician.

Common complaints of athletes regarding the wearing of sports goggles (especially the athlete who has never worn glasses) are that "they limit my peripheral vision," "they distort my vision," "the lenses fog or sweat smudges the lenses," or in general "they're just uncomfortable."

Children may need special attention because of narrow facial features (narrow pupillary distance {P.D}). In some cases, sports goggles with a narrow P.D. may not be available; sturdy children's frames with polycarbonate lenses may be used. Some sports goggles are made with cushions at the bridge of the nose and temple; these cush-

*A person cannot obtain an unlimited driver's license in 80% of our states.

Figure 8: Sports goggles—plano or prescription-capable (polycarbonate).

Figure 9: Over the glasses polycarbonate protector—only protector that consistently "stood up" to lacrosse ball at 45 m.p.h.—most styles broke at nose piece, however, polycarbonate lenses did not break in other sports goggles.

Figure 10: Properly fitted helmet allowing good vision as well as protection of entire face (oral surgeons and dentists also encourage this protector).

ions in some brands are made in neon colors which make the goggles more acceptable for children to wear (Figures 8, 9, and 10).

Street-wear glasses or contact lenses provide no protection in most sports. Street-wear lenses are made from hardened glass (either chemically or heat treated) or plastic (CR 39) and will not withstand the impact energy that may be inflicted during a high eye-risk sporting event (Figures 11, 12, and 13).

The strongest material available today which is clear enough to see through is polycarbonate, which is at least 20 times stronger than everyday streetwear lenses.

The functionally one-eyed athlete necessitates special attention and must wear polycarbonate lenses (3 mm center thickness) in a molded frame with a posterior retaining lip for high eye-risk sporting activities. When a helmet is required it is strongly recommended that both sports goggles and face mask/cage with the helmet be worn (ie "belt and suspenders"). When not participating in sports, the functionally one-eyed person must wear polycarbonate lenses (2 mm center thickness) in a sturdy plastic frame with a posterior retaining lip all waking hours.

Table 5

Eye Protection for Sports

General specifications for sports goggles:

- Polycarbonate* lenses (3 mm center thickness).
- Sturdy frame (preferably polycarbonate) with a posterior retaining lip to prevent lens from being dislodged inward (hitting the eye).
- Molded temple preferred for high eye-risk sports—hinged temple tends to be weak when impacted. Hinges OK for low eye-risk sports.
- Antifog coating.

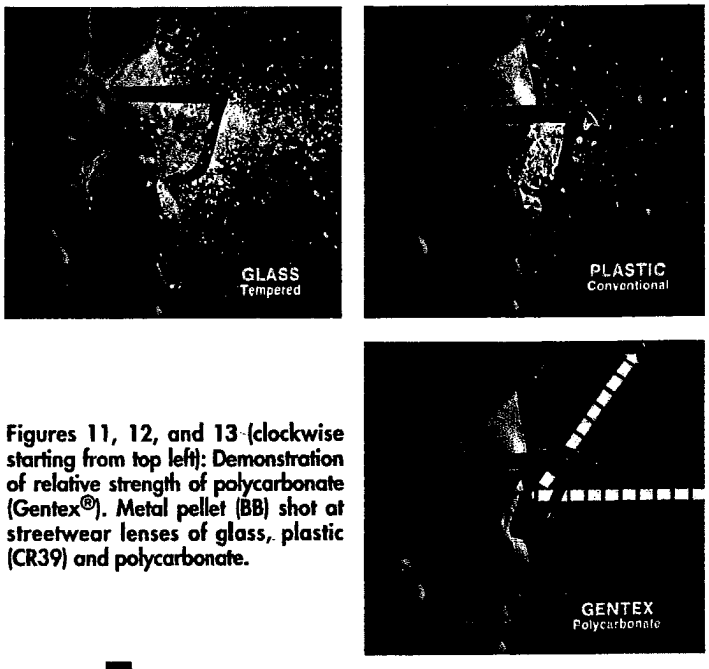
Face guard or cage mounted on helmet:

- Mandated in most collision sports (ie hockey, lacrosse, football). May be polycarbonate or metal.
- Essential for helmet to properly fit with a chin strap to secure for maximum face and eye protection.

**Polycarbonate filters 100% of ultraviolet light.*

Rehabilitation of the Athlete with an Injured Eye

Teams, coaches, and athletes will attempt to pressure physicians (ophthalmologists and primary care) to return the athlete to competition as soon as possible. Common sense medical judgment must prevail under these circumstances. In the case of a less serious injury such as traumatic iritis, an athlete may return to the athletic event sooner when wearing appropriate, properly fitted eye protection. In these cases, as long as the athlete's eye is comfortable, the protective



Figures 11, 12, and 13 (clockwise starting from top left): Demonstration of relative strength of polycarbonate (Gentex®). Metal pellet (BB) shot at streetwear lenses of glass, plastic (CR39) and polycarbonate.

Table 6

Management "Gems"

- Use topical anesthesia only to evaluate patient comfort to expedite exam and obtain visual acuity
  DO NOT USE TO PROLONG PLAY! DO NOT PRESCRIBE!!
- Severe eyelid edema: small amount of crushed ice in plastic sandwich bag—secure top of bag and tape to forehead—no pressure on eye.
- If pressure on injured eye may result in further damage—always safe to shield eye. If no commercial shield available use bottom of styrofoam cup or milk carton.
- Exposure of severe bulbar conjunctival edema with lid closure—use plastic wrap (or half of plastic sandwich bag) tape air-tight over orbit, nose and cheek (acts as "moist chamber"). Not necessary to use antibiotic ointment to prevent drying and infection—may use antibiotic drops to allow easier evaluation.
- Athlete with contact lenses: most are gas permeable and safe to leave in place for short period—alleviates need to manipulate globe.
- Possible to prolong play of athlete having sustained a corneal abrasion with a disposable, low power soft contact lens (ie -0.50).

eyewear may be worn on a temporary basis while the injury heals.

Hopefully, following one potentially serious eye injury, the athlete will feel more comfortable (fewer complaints) and perform at a higher level, appreciating the "safety" of the eye protector.

In the case of more serious injuries, intraocular or keratorefractive surgery an appropriate healing period to which the athlete must strictly adhere should be advised. The athlete may return to play with a strong recommendation to wear appropriate eye protection. Damage is more apt to occur with a direct blow to the unprotected eye or orbit than it would be by a blow to the head or body. □

Please see next three pages for tables regarding sports-related eye injuries.

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Table 7

Sports Related Eye/Orbit Injuries

Site	Pathology	Signs and Symptoms	Comments
Orbit	Edema/hemorrhage	May simulate floor fracture with pseudo-entrapment	Usually resolves in 7-10 days; may need decompression
	Fracture: Floor	Entrapment of inferior ocular tissues; large fracture site	Diplopia results; may result in enophthalmus
	Fracture: Medial wall	Entrapment of medial ocular tissues; subconjunctival or subcutaneous air	Diplopia results with nose blowing
	Fracture: Roof	Air in cranial cavity	Needs IV antibiotics
Eyelids	Ecchymosis/edema	Rule out ruptured globe	Ice to reduce edema
	Lacerations (lac.)		Lids vascular/heal quickly
	Lid proper lac. (non-marginal)	Probe for depth and rule out foreign body	Suture (if deep, in layers)
	Lid margin lac.	Prone to notch	Meticulous micro-repair
	Canaliculus lac.	Interrupted tear drainage	Microscopic closure with intubation
	Avulsion	Possible globe exposure	Save tissue—usually "take" after repair
Conjunctiva	Subconjunctival hemorrhage	Localized or 360°	Rule out scleral rupture; examine retina opposite external site of injury
	Foreign body	Pain with blinking	Often under upper lid—needs eversion
	Laceration	Usually not large or gaping	Rule out scleral laceration; repair if gape exposes deeper tissues
Cornea	Abrasion	Pain with blinking	Usually heals well. Beware delayed recurrent erosion
	Foreign body	Pain with blinking	Superficial: attempt removal; deep: do not attempt removal
	Laceration	Partial thickness	Usually no suturing
		Full thickness	Repair if leaking or flat chamber
Anterior Chamber (A.C.)	Hyphema (Figures 14 and 15)	Vision may be blurred; intraocular pressure may be increased; (special attention to sickle trait positive); blood staining possible (Figure 16)	Treatment controversial but no sports activity for two weeks from trauma; prevent rebleed; potential glaucoma years later

Figure 14: Traumatic hyphema after being struck by batted half-ball.

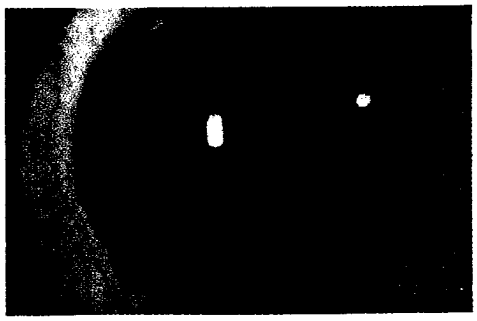

Figure 15: Traumatic hyphema and associated iris injury.

Figure 16: Ten-year-old male struck with baseball resulting in total hyphema with markedly elevated intraocular pressure—cornea blood staining—surgery with peripheral iridectomy.

Table 8

Sports Related Eye/Orbit Injuries

Site	Pathology	Signs and Symptoms	Comments
Iris	Mydriasis (dilated)	Blurred for near	May be permanent
	Inflammation	Blurred vision/photophobia; (may be delayed 1-3 days)	Possible irregular pupil
	Sphincter tear	Same as above	Ragged pupillary border
	Dialysis (iridodialysis)	If large may cause diplopia	Flattening of pupil border in that quadrant
Lens	Cataract (Figure 17)	Blurred vision/cloudy lens/ decreased red reflex	Breaks in capsule allows fluid to enter; posterior capsular common in boxers
	Subluxation (Figure 18)	Partial rupture of zonule;	Chronic inflammation if movement of lens irritates iris
	Luxation	Complete rupture of zonule; phacodenesis or iridodonesis	Potential cornea or retina problem if "drops" forward or back
Vitreous	Hemorrhage	Blurred/decreased vision; floaters	Usually wait 4-6 months before vitrectomy
Retina	Edema (commotio retinae/ Berlin's edema when in macula)	Blurred vision	Usually resolves; watch for macular hole
	Intraretinal hemorrhage	Decreased vision; especially in macula	May result in permanent vision loss
	Retina tear/hole	Photopsia ("flashing lights")	May lead to retinal detachment
	Retinal detachment (R.D.)	Photopsia/floaters/field cut/ decreased vision	Precursor (tear/hole) occurs at time of injury; may be unable to examine most anterior retina initially
Choroid	Rupture	Depends on location and extent as to effect on vision	Macular area prognosis poor; may develop neovascularization later
Optic Nerve	Optic nerve head edema/ hemorrhage	Papilledema	Check for increased cerebro-spinal fluid pressure; may result in some degree of atrophy
	Intrasheath edema or hemorrhage	Optic neuropathy	May need systemic steroids (high dose intravenous) and/or surgical sheath decompression
	Avulsion		No Light Perception TOTAL BLINDNESS

Footnote: Special attention needs to be directed to children in the amblyopic age group. With opaque media (ie corneal laceration leading to central scar, hyphema occluding the pupil, vitreous hemorrhage, retina detachment threatening or involving the macula) may necessitate earlier surgery than in non-amblyopic age group.

Figure 17: Thrown baseball causing traumatic hyphema, iridodialysis and traumatic cataract.

Figure 18: Subluxated lens in basketball player from blunt trauma.

Table 9

Sports-Related Eye Injury Risk/Typical Etiology/Suggested Protection

Sport	Injury Etiology	Protective Device
Basketball	Fingers/elbows	Sports goggles with polycarbonate lenses[1,2,3]
Baseball/Softball	Ball: pitched, line drive, bad hop, misjudged fly	Batting and baserunning: polycarbonate faceguard or other certified protector attached to helmet[2,3] Fielding: Sports goggles with polycarbonate lenses
Racquet/court sports	Ball (direct or ricochet off wall)/ racquet	Sports goggles with polycarbonate lenses[1,2]
Football	Fingers	Polycarbonate shield attached to faceguard; sports goggles with polycarbonate lenses[1,2,3]
Swimming and Pool Activities	Fingers/elbows	Swim goggles with polycarbonate lenses
Hockey (ice/street/Dek®,/field)	Puck, ball/stick	Helmet with polycarbonate faceguard or cage (mandated in organized Junior Hockey);[1,2,3] sports goggles for street hockey if faceguard not worn[4]
Lacrosse: Men	Not apply	Helmet and full face protection mandated
Lacrosse: Women	Ball or stick (rules prohibit stick in imaginary cylinder around head)	None mandated but may (and should) wear certified polycarbonate sports goggles[2,3]
Soccer	Ball, finger, elbow	Sports goggles with polycarbonate lenses[2,3]
Tennis: Singles	Ball	Sturdy frame (hinged) with polycarbonate lenses[2,3]
Tennis: Doubles	Ball (especially when "up on net")	Sports goggles with polycarbonate lenses[2,3]
Cycling	Falls, tree branches, rocks from vehicles	Sturdy frame (hinged) with polycarbonate lenses[2,3]
Track and Field (Cross Country)	Fingers, falls, tree branches	Sturdy frame (hinged) with polycarbonate lenses[2,3]
Boxing, Wrestling, Full Contact Martial Arts	Gloves, fingers, elbows, feet	Adequate protection not available

Footnotes:
[1]Goggles without lenses do not offer adequate protection.
[2]All one-eyed athletes must wear appropriate polycarbonate eye protection for sports. Athletes with previous eye trauma or intraocular or keratorefractive surgery must also wear sports goggles with polycarbonate lenses for added protection.
[3]For sports in which a helmet with an eye protector (shield or cage) is worn functionally one-eyed athletes and those athletes with previous eye trauma or intraocular or keratorefractive surgery must also wear sports goggles with polycarbonate lenses for added protection.
[4]A street hockey ball can penetrate the eye opening of a molded goalie mask.