PROTECTION

THE EYE NEWSLETTER • VOLUME XXIII • SPRING, 1998
ROBERT M. SCHARF, M.D. • (972) 596–3328

Trauma is an epidemic with high social costs. Ocular trauma is the most common ophthalmic reason for hospitalization. National projections estimate annual U.S. hospital charges of $175 million to $200 million for 227,000 eye trauma days in the hospital. It is estimated that, of the two million Americans who sustain eye injuries each year, 40,000 are legally blinded in the injured eye. Legal blindness is defined as when the best-corrected visual acuity is 20/200 or less. Depending on the study, the incidence of eye injury from sports ranges from 10% to 40%.

Of course, the most effective treatment is prevention. Essentially, all sports eye injuries can be prevented with protective eyewear. Prevention should be emphasized by all who prescribe, manufacture, or dispense eyewear, as well as by those who create and enforce the rules in the athletic or work environment.

However, prevention is often not emphasized. Sports injuries are not accidents; but are, like most other injuries, predictable events. When they are studied in reference to the basic epidemiological factors of time, agent, host, and environment, they exhibit definite patterns with characteristics that can be altered by changes in the rules or by protective devices (Fig. 1). Educating the public about the risks of eye injury in various sports and to the benefits of available protective equipment can help prevent injury to well over 100,000 eyes each year.

Fig. 1

The Nature of Sports Eye Injuries

Sports cause the entire range of eye injuries starting with corneal abrasion and including ruptured globe. The severity of the injury depends not only on the moving object's mass, speed, hardness, size, and sharpness but also on the site of contact and any predisposition of the individual eye to injury. Injuries are distributed in a wide range with large, soft, slow-moving objects causing the mild blunt trauma injuries of periocular contusion and corneal abrasion. As the moving object transmits more energy to the eye due to smaller size, greater hardness, increased mass, or greater velocity, injuries such as iritis (inflammation of the iris), hyphema (bleeding from the iris), chorioretinal (the retina and the next deeper layer, the choroid) scarring, and retinal detachment are the result. The severity of the injury is shifted in the direction of globe rupture by decreasing the size of the moving object while increasing its hardness and speed. As the object becomes larger, some of its energy is absorbed by the bones and soft tissue of the orbit, and globe rupture is less likely.

Sharp Objects

Sharp objects commonly cause laceration of the lids and globe and are associated with intraocular foreign bodies and retinal detachment. Accident debris is a hazard of motor sports, while broken branches typically injure mountain bikers and cross-country equestrians. Broken foils are common in fencing, but penetration of the face mask is extremely rare.

The most common cause of this type of injury is eyewear failure and this is almost completely preventable. Since globe rupture in this manner can be caused only by spectacles shattering into extremely sharp fragments and penetrating the globe, the amount of force necessary to rupture the globe is the same as the energy required to shatter

a lens or break a frame. A sports accident that would usually cause traumatic iritis in an individual wearing safe spectacles or no spectacles at all can, in a patient wearing unsafe eyeglass lenses and/or frames, result in a lacerated globe. The impact from a 40-mph tennis ball will shatter a high-index lens with a thickness at the center of 1 mm (for comparison, see Figures 2 and 3). A golf ball at 35 mph shatters the most commonly prescribed glass or allyl resin plastic (standard CR-39 plastic) industrial and streetwear spectacles and sunglasses.

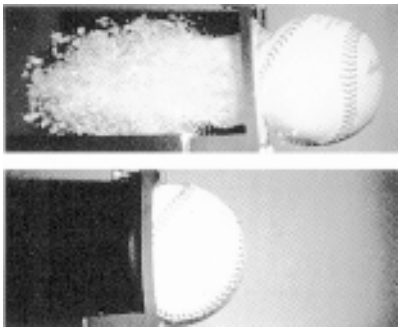


Fig. 2 A baseball strikes a glass industriall lens (above) and a polycarbonate lens (below).

Many eyes have been saved because the individuals were wearing the newer plastic polycarbonate lenses that did not shatter when hit by a tennis ball or baseball or as the result of a bicycle accident. Only polycarbonate lenses have sufficient impact resistance for use in sports. The safest, most rigid polycarbonate lens is the American National Standards Institute (ANSI) Z87.1-1989 industrial lens with a 3-millimeter center thickness. The 1.5-millimeter center thick street-wear polycarbonate lens is also quite strong but deforms more with severe impact (e.g., from a baseball). The 1.0-millimeter center thick fashion polycarbonate lens is too flexible for most sports and can be dislodged from the frame on impact. *It is important to realize that ANSI Z87 glass and standard (CR-39) plastic lenses do not have sufficient strength for sports use.*

Small, High-Speed Blunt Objects

Lacerations of the globe with brain damage and poor prognosis are all too commonly caused by BBs and shotgun pellets. Education in the proper use of firearms is critical to the prevention of eye injuries. Safe use includes avoiding alcohol consumption while hunting and the use of the appropriate protective eyewear. Some BB gun manufacturers include safety eyewear and a safety poster in their product packaging. The educational programs of the National Rifle Association encourage all users to treat BB guns and air rifles with the same respect as a firearm. The fact that there have been no eye injuries reported during organized competition demonstrates that BB guns, air rifles, and firearms can be very eye-safe if used with appropriate precautions.

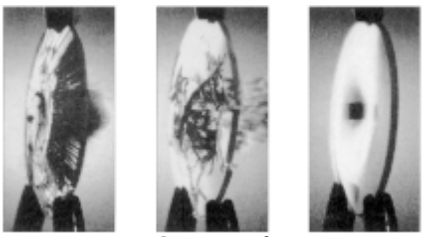


Fig. 3 *Photographs of these high velocity experiments are reproduced here exactly as filmed, without retouching.*

Larger Blunt Objects Smaller than the Orbital Opening

Paint balls, squash and golf balls, golf club heads, hockey sticks, ski poles, polo mallets, extended fingers, and small tree branches all fit into the orbital opening and frequently cause a blowout type of globe rupture that has an extremely poor visual prognosis. The small-fast-hard paint ball, golf ball, hockey stick, and polo mallet are especially devastating. The mechanism of eye rupture is probably due to an extreme rapid elevation of intraocular pressure.

Fig. 4

Use of protective eyewear that conforms to the standards of the American Society for Testing and Materials (ASTM) decreases the incidence of injury from sports activities. No eye injuries have been reported by any of the following athletes: a squash player wearing a protector that passed the ASTM F-803 standard, a hockey player wearing a face mask that passed the ASTM F-513 standard, or a skier wearing a protector with a polycarbonate lens that passed the ASTM F-659 standard. The protective eyewear standard ASTM F-1776 has been developed for paint ball eye protectors, and a standard for polo is under consideration by polo organizations.

Blunt Objects Larger than the Orbital Opening

Sports injuries of this type are the most common and usually result in ocular and periocular contusion, hyphema, angle recession (the iris is pushed deeper into the eye), retinal detachment, cataract, or blowout (the bones

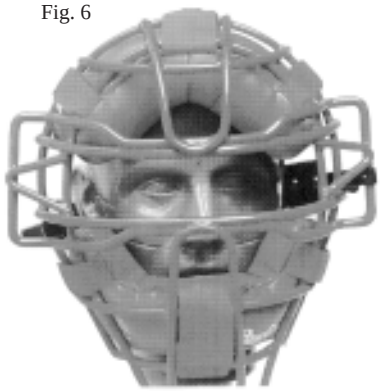
fracture away from the globe) fracture. Since a good deal of energy is absorbed by the tissues surrounding the orbit and are dissipated as the moving object deforms, the rise in intraocular pressure is slower and globe rupture is much less common. However, the loss of central vision caused by retinal swelling and macular (the center of the retina with 20/20 vision) scarring is not at all rare. Hands, elbows, balls, and boxing gloves cause this type of injury. Contrary to common belief, balls larger than 4 inches in diameter, such as soccer and volley balls, can deform enough to cause significant intraocular injury and retinal detachment. This type of eye injury is common to unprotected basketball (from hands and elbows), baseball, racquet sport, and soccer (from the soccer ball) players.

Fig. 5

There have been no reported eye injuries to any of the following: youth baseball batter or base runner wearing a protector that passed the ASTM F-910 standard, baseball catcher wearing a catcher's mask, or racquet sport player wearing a protector that passed the ASTM F-803 standard. Football eye injuries have been reduced 90% by the face mask, with no injuries reported when a polycarbonate shield was in place over the eye opening of the wire mask. There is no effective protection for boxing.

Massive Head Trauma

Fig. 6



Blows to the skull with direct or indirect injury to the eyes or visual pathways may result in permanent or temporary vision loss. The huge forces required to produce these injuries can be encountered in sports such as the collision sports of skiing, cycling, and motor sports. For sports with high energy levels such as football and hockey, it is desirable to increase the time and area of impact and to absorb a major part of the energy into an integrated face mask/helmet system. However, helmets may reduce the impact to the skull but they cannot prevent all head injuries and they offer no protection to the neck.

Protector Types

Eye protection must be considered in relation to the energy potential and the risk of eye injury in the sport. There are several protector types that are appropriate for a range of sports. It has been demonstrated in hockey, youth baseball, and the racquet sports that, with properly chosen eye protection, eye injuries from sports can be reduced to near zero.

Face and Eye Protector Attached to a Helmet (figures 4 and 5)

Many sports involve huge collision forces that may shatter facial bones, injure the brain, and cause eye injuries. Sports helmets must be specific to the sport: a lacrosse helmet is ineffective for motorcycling, and a football player would not get proper protection from an equestrian helmet. A face protector must be specifically designed to prevent the eye injury and be attached to a helmet designed for that sport. Effective face protector/helmet combinations are available for hockey, football, lacrosse, baseball (batter), downhill ski racing, and motor sports.

Fig. 7

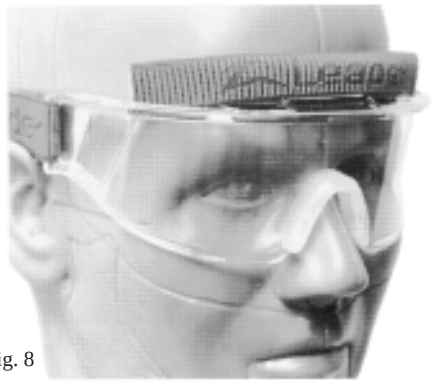


Fig. 8

Helmet with Separate Eye Protector

Some sports activities have enormous potential for brain injury, but there is less risk of causing eye injury. A helmet is essential for each of these sports, while eye protection may be separate. All eyewear should be polycarbonate, but each sport has special eyewear requirements. The jockey and mountain bicycle racer require protection from mud and dirt splatter and the ability to peel off caked layers of mud without slowing down. The cyclist and slalom ski racer need sun and wind protection. The polo player who prefers separate eye protection needs a protector that will not shatter on impact of a mallet or ball.

Face-Supported Eye and Face Protector (figures 6 and 7)

Several athletic activities have a high risk of eye and face injury, but the energy is low enough that the forces can be absorbed by the facial bones and forehead by the padding of the protector. Effective face-mounted protectors are available for fencing, baseball catcher, and paint ball. The face-supported ice hockey goalie mask is ineffective and should not be used.

Suggested Sports Eye Protectors

1) *Face and eye protector attached to a helmet (figures 4 and 5)*
   Sports with high collision energy potentials and high eye injury risk: motor sport racing, downhill ski racing, football, men's lacrosse, baseball batter/base runner, hockey, and polo
2) *Helmet with separate eye protector*
   Sports with high collision injury potentials and moderate to high eye injury risk: horse racing, polo, cycling, and slalom ski racing
3) *Face-supported eye and face protector (figures 6 and 7)*
   Sports with high eye injury risk but less risk of brain injury: baseball catcher/umpire, fencing, and paint ball
4) *Eye protector (figure 8)*
   Sports with high eye injury risk but less risk of injury to head, face, and brain: racquet sports, women's lacrosse, basketball, baseball fielder, and soccer
5) *Streetwear polycarbonate lens and frame or lightweight polycarbonate sports sunglasses (figure 9)*
   Sports with low risk of eye injury or moderate risk with low energy potential for injury: track and field, fishing, and golf

Fig. 9

Safety Recommendations

1. Polycarbonate lenses are suggested for all children, functionally one-eyed people, and active adults. Since all polycarbonate lenses absorb ultraviolet and are scratch resistant, no further UV or scratch-resistant coating is suggested.
2. For sports that have the potential for eye contact with a ball or racket, 3-millimeter thick polycarbonate lenses in a frame that passes the ASTM F-803 standard are recommended.
3. For working with power tools or any exposure to flying chips, use eyewear with lateral protection that meets the ANSI Z87 Goggles standard are the safest. Use only polycarbonate lenses.
4. Sports with high impact, such as ice hockey, require a face shield mounted on a helmet designed for the sport.
5. Many workplace situations (e.g., using a chain saw) require safety glasses and a helmet with a face shield designed for the activity.

Accidents are by their very nature unpredictable, but frequently preventable. It seems to be such a nuisance to wear distracting head/eye protective gear, but our eyes are truly a precious commodity.