Boxing: Medical Care In and Out of the Ring

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Boxing may well be the oldest sport known to mankind and probably the most controversial. Injuries are common in boxing, occurring most often to the head, neck, face, and hands. Brain injury, both acute and chronic, is the major risk for potential catastrophe. Medical care for the boxer extends beyond the competition in the boxing ring; the ringside physician is responsible for protecting both boxers and must make quick decisions about their continued participation based upon a limited examination. A thorough knowledge of the rules and regulations of boxing is necessary for the ringside physician to effectively care for the athlete. In spite of the perceived brutality associated with the sport, most injuries are minor, although serious injuries and deaths do occur, most commonly due to brain injury. Given the potential for catastrophic injury, the ringside physician must be prepared and equipped to care for the boxer.

Introduction

Concerns about the risks of boxing have fueled attempts for many years to ban it as a sport. Viewed as a vicious, archaic, pugilistic activity with the sole purpose of causing harm, boxing is felt by many to have no place in today's world. Evidence suggests boxing was invented around 1500 B.C. in what is now known as Ethiopia [1]. It spread to ancient Egypt and throughout the Mediterranean, as depicted in a Minoan fresco showing two youths boxing on the island of Santorini (Fig. 1) [2]. Modern boxing bears little resemblance to the ancient Greek sport in which competitors fought to the death. Upon introduction to the ancient Olympics in 688 B.C., boxers wore headgear and long, leather wrappings to protect the hands while increasing the force of blows. The Romans escalated the cruelty by introducing the caestus, an iron-studded gauntlet with metal spikes fixed on the knuckles, and the myrmex (limb piercer), a spur-like instrument of bronze [1]. Finally banned in Rome about 30 B.C. because of the severe brutality, boxing became obsolete for many centuries until its resurrection in England in the late 17th century.

Modern boxing arose from self-defense academies and a desire for recreational and physical activity. The first boxing rules were introduced in 1743 by Jack Broughton, who became known as the "father of English boxing." Rules for amateur boxing were further refined by the Marcus of Queensbury in 1867, when boxing became viewed as a gentlemanly sport [2]. It was during this time that prize fighting began, with bare-knuckled competitors wagering against one another along with any number of side bets occurring as well. Modern amateur boxing made its debut during the 1904 Olympic Games in St. Louis and, with ongoing controversy regarding its safety, has continued to evolve to this day.

Common Injuries

Although significant concern exists regarding the potential risks of boxing, injury rates in amateur and female professional boxing compare favorably with other contact sports. In a cohort of amateur and professional boxers studied over 2 years, there were 2.0 injuries per 1000 hours of boxing [3]. This compares with injury rates of 4.36 injuries per 1000 athlete-exposures in football, 2.5 in wrestling, and 2.4 in soccer in high school athletes. A medical survey of female boxing in Italy found it to be much safer than expected [4]. Injuries in male professional boxers, however, seem much more common. Bledsoe et al. [5] reviewed professional boxing data from the state of Nevada from September 2001 through March 2003 and found the overall incidence rate of injury was 17.1 per 100 boxer-matches, or 3.4 per 100 boxer-rounds. In a 16-year study of injuries sustained during competition in professional boxers in Victoria, Australia, Zazryn et al. [6] found an injury rate of 250.6 injuries per 1000 fight-participations. Further research is necessary to determine mechanisms of injury and long-term outcomes from these injuries in order to develop effective injury prevention strategies.

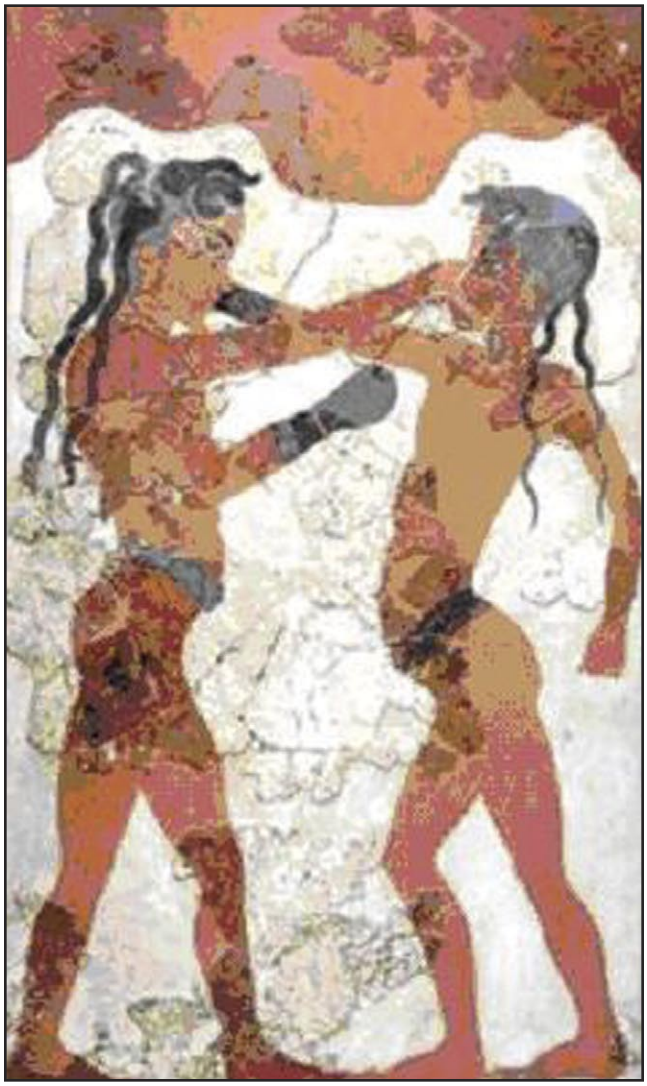

Figure 1. Youths boxing in a Minoan fresco on the island of Santorini.

The most common sites injured in boxing are the head, neck, face, and hands. Bledsoe et al. [5] reported facial lacerations accounted for 51% of all injuries, followed by hand (17%), eye (14%), and nose (5%) injuries. Zazryn et al. [6] reported the head, neck, and face as the most commonly injured areas, comprising 89.8% of injuries, with 75% being lacerations. Specifically, injuries to the eye region (45.8%) and concussions (15.9%) were noted as the most common [6]. Nasal injuries with deviated nasal septum are also frequently reported [4]. Although not as common, shoulder and knee injuries have proven to be the most debilitating injuries [7]. Female boxers have lower injury rates than their male counterparts, with men injured three times as much [5]. Male boxing matches are more likely to end in knockouts and technical knockouts than female matches, and those boxers that lose by knockout have twice the risk of injury compared with those who lose by other means [5].

Initial management for most acute boxing injuries is no different than in any other sport; however, return to competition may be prolonged due to the demands of the sport and restrictions of casting or splinting. Mild acute traumatic brain injury or concussion requires restriction from sparring and competition until all symptoms have subsided and the boxer has returned to normal cognitive status. Facial lacerations are repaired according to standard methods but should be given ample time for healing in order to prevent unnecessary reinjury. Fractures of the bones in the hand or wrist must be completely healed prior to sparring and competition. Minimal angular deformity of metacarpal fractures should be accepted and efforts to restore near anatomic alignment are preferred. Sprains and strains limiting the athlete's mobility or flexibility may result in prolonged return to play. Ocular injuries should be thoroughly assessed, particularly for evidence of retinal detachment.

Boxer's knuckle is an injury fairly unique to boxing that results from repeated blows to the extensor tendon retinaculum and hood as it crosses the metacarpophalangeal joints of the hand. It most commonly affects the third finger metacarpal, resulting in radial or ulnar subluxation of the extensor tendon due to damage of the sagital bands. Swelling, tenderness, decreased extension of the joint, and palpable subluxation of the tendon are characteristic signs. Immobilization of the joint in extension for 4 to 6 weeks may be attempted but is usually not as successful for boxers. In the competitive boxer, boxer's knuckle is best managed with surgical repair of the sagital bands and centralization of the extensor tendon [8].

Metacarpal bossing may occur in the carpometacarpal joint of boxers due to recurrent trauma. Most common at the base of the index or middle finger, metacarpal bossing results from hypertrophy of the carpometacarpal joint with characteristic changes of degenerative joint disease. Metacarpal bossing occurs more commonly in experienced boxers due to increased duration of boxing and repeated microtrauma to the joint. It is best treated with rest and added protection of the hand. Corticosteroid injections may be helpful for acute exacerbations but repeat use should be avoided. Chronic pain is common and may be extremely debilitating for the boxer.

Brain Injury

Brain injury, both acute and chronic, is the greatest potential risk that occurs in boxing. Acute subdural hematoma is the most common cause of death in boxing, and chronic traumatic brain injury (CTBI) is the most feared complication [9–11]. CTBI, also known as chronic traumatic encephalopathy, dementia pugilistica, or "punch drunk syndrome," shares many of the characteristics of Alzheimer's disease (ie, neurofibrillary tangles, diffuse amyloid plaques, acetylcholine deficiency, and tau immunoreactivity) and parkinsonism, and results from the cumulative effects of concussive and subconcussive blows to the brain [10,12]. A genetic predisposition may also exist in some individuals with the presence of the

apolipoprotein E genotype, which has also been linked to Alzheimer's disease [12]. CTBI has been reported in as many as 17% to 18% of professional boxers and rarely occurs in amateur boxers, primarily because of the lack of exposure time to the sport of boxing [9,12].

Defining a specific measure of head trauma that leads to CTBI is difficult, but increased exposure to repeated blows to the head appears to be the greatest risk. Risk factors for CTBI associated with increased exposure include retirement after age 28, boxing longer than 10 years, participating in more than 150 bouts, increased sparring exposure, history of knockout or technical knockout, poor performance, or being a boxer who is difficult to knock out [9,12]. Symptoms of CTBI usually present well after a boxer's career has ended, generally after the age of 50 [12]. Studies assessing short-term effects on cognitive function in boxers within 1 month following subconcussive head trauma demonstrated no evidence of neuropsychological dysfunction [13–15]. A 9-year controlled, prospective neuropsychological assessment of amateur boxers found no evidence of neuropsychological deterioration linking their exposure to CTBI [16]; therefore, a specific dose response for exposure to head blows and the development of CTBI cannot be established. Furthermore, CTBI may represent a progressive neuropathological lesion or the aging process superimposed on a fixed neurologic injury [12].

Management of head injuries in boxing

Effective management of head injuries in sport begins with prevention. Concern for the health of the amateur boxer has led to rule changes over the past two decades that have improved the safety of amateur boxing and outpaced similar efforts in professional boxing [17]. Amateur boxing has made great efforts to reduce the focus on head blows, making the main objective to score points with any legal blow. Efforts to protect the amateur boxer from injury include mandatory headgear, mouthpiece, and a change to larger gloves with more padding. Exposure to repeat blows to the head are reduced, with Olympic-level or open-boxing bouts limited to three or four 2- to 3-minute rounds, with shorter rounds for younger competitors. All amateur boxers participating in sanctioned events of USA Boxing are required to be registered and in possession of a passbook documenting every bout in which they have participated, the result, the opponent, and a pre- and postbout medical examination.

Amateur boxers who receive several hard blows to the head or demonstrate signs of head injury during competition receive mandatory restrictions from sparring and competition for 30 days or longer depending upon the severity of injury. USA Boxing rules mandate a 30-day restriction for minor head injury with no loss of consciousness, a 90-day restriction for loss of consciousness less than 2 minutes, and a 180-day restriction for loss of consciousness in excess of 2 minutes [18•]. Boxers who have completed their restriction period must be examined and cleared by a physician prior to their return to boxing. Another head injury occurring within 90 days after completing the restriction period results in 90 to 365 additional days of restriction. Medical restrictions are enforced through collection of the athlete's passbook, which is required for participation and is returned after clearance by a physician.

Management of head injuries in professional boxing varies according to venue location and sanctioning body. Mandatory restrictions for head injuries in professional boxing exist in theory but occur rarely [19]. Medical requirements for professional boxers vary widely between states, ranging from a prefight physical and clearance by a physician to mandatory electroencephalogram, head CT/MRI, neurological examination, and neuropsychological testing, with a trend toward increasing medical monitoring. It is predicted that the incidence of boxing-related CTBI will decrease in the current era of professional boxing due to a reduction in the exposure to repetitive head trauma and increasing preparticipation medical and neuroimaging assessments that can lead to early detection of brain injury [20]. Newer technology may eventually lead to safer participation for boxers. A computerized program has been developed to analyze the number and types of punches landed in a bout and could provide sufficient data at ringside to stop matches that might result in fatalities [21]. Unfortunately such a process becomes less effective as matches become more competitive; therefore, further refinement and study are needed.

Blood-borne Illnesses

Transmission of blood-borne disease in boxing is a theoretical yet deadly concern. Contact with blood or contamination of open wounds or mucous membranes by infected blood may transmit HIV, hepatitis B virus (HBV), or hepatitis C virus, placing the athlete at risk for deadly diseases such as AIDS, cirrhosis, or hepatocellular carcinoma. Although there are no confirmed reports of HIV transmission during any sport, including boxing, it has been reported during bloody street fights on more than one occasion [22]. HBV is transmitted in the same way as HIV but its risk of transmission is actually 50 to 100 times greater than transmission of HIV. The concentrations of HBV in the blood compared with HIV are much higher. HIV is readily susceptible to a variety of disinfectants and is reduced by 90% to 99% within several hours after drying, whereas HBV is resistant to drying, ambient temperatures, simple detergents, and alcohol and has been found to be stable on environmental surfaces for at least 7 days [23]. Physicians, referees, coaches, and trainers are also at risk if they come in contact with infected blood from the boxer. Transmission of hepatitis C virus has been reported as a result of sharing a handkerchief used to dry bleeding wounds after a bloody fight [24]. Any individual working with or caring for boxers should follow universal blood precautions and always wear protective gloves

before coming in contact with blood, blood components, bloody equipment and gloves, or the boxers themselves. In spite of the theoretical risk of blood-borne infection in sport from contact with blood, body fluids, and other fluids containing blood, the main methods of transmission in athletes are similar to those for the general population (ie, unsafe sexual activity and sharing needles) [22].

USA Boxing (amateur boxing) rules prohibit athletes known to be infected with HIV or HBV from competition [18•]. Mandatory testing or widespread screening of athletes for blood-borne diseases in amateur boxing is not required, although yearly HIV testing and HBV immunization is recommended. Professional boxing rules and regulations regarding testing for blood-borne diseases vary by state and country. In the United States, medical clearance and mandatory testing is governed by the respective State Boxing Commission. Most states require a negative test for HIV and HBV prior to boxing professionally. Tests for blood-borne diseases for professional boxers are not required in Colorado, Hawaii, Iowa, Maine, North Dakota, Oklahoma, Vermont, Virginia, West Virginia, and Wisconsin.

Role of the Ringside Physician

The role of the ringside physician is to protect and care for each boxer before, during, and after competition. Before each competition, boxers should undergo a pre-bout examination, usually in conjunction with weigh-in, and be examined closely for injuries that may have been sustained during training or their previous bout. Professional boxers may have additional testing requirements for licensing depending upon the state. In amateur boxing, athletes may compete on consecutive days and should receive close scrutiny when competing in a tournament. It is not uncommon for an individual to advance to the next round and, upon subsequent evaluation, be found to have sustained an injury that precludes his or her continued participation. In either professional or amateur competition, no boxer should be allowed to compete wearing a dressing on a cut, wound, laceration, or abrasion on the scalp or face including the nose and ears [18•]. Excessive swelling around the eye causing limited field of vision or active herpetic lesions of the face are examples of disqualifying findings. Suspected fractures of the face, nose, or metacarpals should be evaluated with radiographs and are potentially disqualifying. The history or presence of a retinal detachment, whether or not it has been treated, is disqualifying. Although somewhat controversial, refractive surgery of the cornea is felt to be a relative if not absolute contraindication to participation in boxing.

Unlike in many sports, in boxing, the ringside physician is an official and has the authority to intervene whenever necessary. This authority comes with a responsibility to act prudently and not interfere with the normal conduct of the bout. The ringside physician acts in conjunction with the referee to ensure that each competitor is able to effectively defend him or herself throughout the course of a bout. Whenever it is felt that a boxer cannot do so or there is risk of further injury, the referee may stop the bout or request an evaluation and guidance from the ringside physician. If at any time the ringside physician feels a boxer is in danger, the physician may signal the timekeeper or mount the apron of the ring and the referee will suspend the bout to allow examination of the boxer.

The ringside physician may be asked to evaluate boxers' injuries during competition in order to determine if they are safe to continue or should be disqualified. Injuries may not be treated during the bout without disqualifying the boxer and discontinuing the fight; however, treatment of injuries obviously disqualifying a boxer should begin immediately upon their recognition. Epistaxis or lacerations may be evaluated with gentle pressure to determine the severity of bleeding and extent of injury without disqualification unless specific treatment is necessary. The physician may indicate to the referee between rounds that he or she would like to evaluate a boxer who appears injured. The referee will bring the boxer to the physician after initially starting and then immediately stopping the next round so as not to interfere with the boxer's time in his or her corner with his or her manager. The most common reasons for disqualification during a bout are uncontrolled bleeding, laceration, or head injury.

The Cutman

Any discussion of the medical treatment of professional boxers would be incomplete without mention of the ubiquitous cutman. Immortalized in the 1976 film *Rocky,* cutman Benny Stein, played by former boxing trainer Al Salvani, famously cuts open Rocky's swollen eye, allowing him to continue and win the fight. Real-life cutmen are invaluable to professional boxers; they are responsible for controlling or stopping bleeding from lacerations and nose bleeds that would otherwise result in the boxer's disqualification. Amateur boxing disallows the use of any medications to treat bleeding during a bout [18•]. Professional boxing allows cutmen or trainers to use any topical treatment they may have at their disposal. The cutman is limited to 1 minute (and usually less) between rounds to control the bleeding. Eye or face swelling is frequently treated with an enswell, a smooth metal device kept on ice that is pressed to the swollen area, effectively "milking" the swelling from the tissues. The specific techniques and secrets used by a cutman for treating lacerations and bleeding are closely guarded and passed down only in apprenticeship form. The prophylactic application of petroleum jelly to the face retards lacerations. Medications and substances frequently used in various combinations to control

bleeding include Avitene (Davol Inc., Cranston, RI), adrenaline chloride, thrombin, Surgicel (Ethicon Endo-Surgery Inc., Cincinnati, OH), and Gelfoam (Pharmacia & Upjohn, Kalamazoo, MI). These substances are frequently mixed with petroleum jelly or other ointments and applied with a cotton swab (always present behind the ear of the experienced cutman). Experienced ringside physicians appreciate the role and duties of cutmen and allow them an opportunity to control or stop bleeding before disqualifying the boxer.

Conclusions

Medical care in and out of the boxing ring requires a thorough knowledge of the sport's rules and familiarity with common boxing injuries. Modern boxing has evolved tremendously from its beginnings in Greece yet still remains controversial. The most common injuries in boxing are to the head, neck, face, and hands, the majority of which are lacerations. Acute or chronic brain trauma is the most dreaded and severe injury seen in boxing and is best managed with prevention. Blood-borne disease transmission remains a theoretical concern requiring the practice of universal blood precautions. The role of the ringside physician extends before and after the competition, including the prebout examination, ringside coverage of the bout, and postbout evaluation and treatment of injuries. In spite of the perceived brutality of boxing, it remains a relatively safe sport; however, the ringside physician must be prepared for potential catastrophic injury and act quickly to protect and care for the boxer.

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