Evaluation and treatment of trauma related collapse in athletes

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Abstract Although blunt traumatic injuries are common in athletes, life-threatening trauma is fortunately rare. Most current literature has focused on nontraumatic causes of athlete death though traumatic injuries may be more common. Although prevention of these injuries may be more difficult than nontraumatic causes, prompt recognition and treatment is paramount. Common traumatic causes of collapse athlete generally involve the head, neck, and trunk and are more frequent in collision sports. Other higher risk sports include track and field, cheerleading, snow sports, and those involving motorized vehicles. Health care providers who participate in sports coverage should be aware of the potential for these injuries as emergency treatment is required to maximize outcomes. Emergency action plans allow providers to expediently activate emergency management services while providing treatment and stabilization.

Keywords Trauma · Sports injury · Collapsed athlete

Introduction

Minor sports injuries are very common in athletics of all levels and even more serious sports injuries, fractures, ligament injuries etc, are generally not life-threatening. Fortunately life-threatening injuries are rare in sporting activity at all

levels. While much attention recently has focused on nontraumatic causes of death and disability in athletes (eg, cardiac), traumatic causes of life-threatening injuries are, maybe, more common [1•]. The treatment and evaluation of an athlete who collapses in the setting of a traumatic injuries requires immediate recognition of causes as emergency treatment is necessary to improve outcomes. Emergency action plans are paramount to allow sports medicine staff to react timely and with appropriate treatment.

Epidemiology

The true incidence of trauma related death or near death incidence in sports is difficult to define as most of the information relies on self-reporting or use search engines to review media reports. The National Center for Catastrophic Sports injury research (NCCSIR) has available data base for causes of death in high school and collegiate sports [1•]. NCCSIR defines a direct injury as one that resulted directly from participation in the skills of the sport and an indirect injury as one that was caused by systemic failure as a result of exertion while participating in a sport activity or by a complication that was secondary to a nonfatal injury. Using these definitions from 1982 to 2012 there were almost 1400 direct catastrophic injuries in high and collegiate sports. The majority, 81 %, occurred at the high school level with 173 fatalities occurring in that time frame. In contrast there were 26 fatalities at the collegiate level. This difference is in part explained by participation numbers at each level with overall rates of direct catastrophic injury for the 2011–2012 season being .59 and 1.98 per 100,000 participants in high school and college athletes, respectively [1•]. While this tracking suggests direct causes are more common than indirect others have found the opposite. A 30-year review of the US National Registry of Sudden Death in Young Athletes found 14 % of deaths were

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related to trauma, this is 4-fold less than deaths attributed to cardiovascular causes [2•]. Some of this discrepancy may be accounted for by whether or not the data set was reporting on catastrophic injury including deaths or deaths alone.

Data on recreation sports is limited. Rates of severe injury/death in skiing are .71/1,000,000 event days [3]. From 2003 to 2010, 72 catastrophic injuries were reported by the All Japan Judo Federation [4]. A study using a national emergency room data base reported 14 % of life-threatening injuries in children to be sports related [5]. Rates of death or major trauma in Australian adults during sports and recreation activities was found to be 6.3 per 100,000 per year [6].

Sports where injuries are most commonly reported are ice hockey, football, and gymnastics but proportionally baseball, lacrosse, and track and field had the most direct catastrophic injuries [1•, 2•, 7, 8]. Cheerleading accounts overwhelming for the largest portion of direct injury in female athletes [1•]. Recreationally cycling and motor-sports also account for a large proportion of these injuries [6]. In American high school football most fatalities occurred during games [7]. Data on injuries sustained during practice vs competition is not readily available for most other sports

Head injuries account for the largest amount of fatal injuries with commotio cordis accounting for another significant portion [1•, 2•, 3–8, 9•]. Cervical spine injuries account for a large portion of nonfatal catastrophic injuries; contributing a smaller portion of fatal injuries [1•, 2•, 4, 7, 8].

General Principles (Fig. 1)

Given the nature of many sports it may be difficult to ascertain direct traumatic mechanism of collapse compared with indirect causes. Therefore, evaluation of any athlete with a traumatic collapse should be consistent with the general emergency assessment starting with the ABCs (Airway, Breathing, Circulation). Early activation of emergency medical services should be performed. Immediate access to automated external defibrillators is important as both traumatic (commotio cordis/cardiac contusion) and indirect causes have been shown to have improved early defibrillation [9•, 10]. Seizure-like activity is commonly seen with cardiac arrhythmias and may be seen after head trauma. This presentation should not delay the start of cardiopulmonary resuscitation, application of an automated external defibrillator, or emergency care for head trauma [11, 12]. It is highly recommended that all events and institutions have an emergency action plan in place. Emergency action plans allows providers to:

- (1) Have early access to automated external defibrillators
- (2) Expediently activate emergency services
- (3) Outline ahead of time the local medical resources.

This information should include trauma capabilities of local and regional medical facilities. This is extremely important in traumatic injury as early transport to a facility where definitive care can be provided improves outcomes in traumatic injuries [13–16]. This is additionally important as other than early defibrillation most prehospital treatments, i.e. intubation, have not been shown to improve outcomes [17, 18].

Head and Neck

Brain injury is the leading cause of direct traumatic catastrophic injury and death with the subdural hematomas being the most common injury [1•, 2•, 3–8, 9•]. A smaller portion of head injuries involve intracerebral hemorrhage and diffuse axonal injuries [19–21]. Although helmets may afford some protection from blunt brain injury, they have limitations as evident by football being one of the highest reported rates of death and disability from brain injury [1•, 2•, 7, 22]. Athletes may present with a brief period of lucidity followed by collapse or present altered consciousness. Routine imaging for athletes with concussion is not indicated and should only be undertaken for concern of intracranial pathology [23]. There is a paucity of literature to guide sideline evaluation of head injuries. Using studies from emergency/trauma literature can aid in determining the need for further imaging. Several clinical decision rules (Canadian CT Rules, New Orleans Criteria and National Emergency X-Radiography Utilization Study (Nexus II)) have been developed by studying emergency room patients [24, 25]. These rules in general apply only to those patients >16 years old. In children similar guidelines have been developed, the Canadian Assessment of Tomography for Childhood Head Injury (CATCH), the Children's Head Injury Algorithm for the Prediction of Important Clinical Events (CHALICE), and Pediatric Emergency Care Applied Research Network (PECARN) [26•]. If applied to athletes these rules would likely lead to a significant overuse of imaging. However, while it may be difficult to fully extrapolate these guidelines to the sideline evaluation of athletes, there are several clinical findings that may be useful for clinicians.

In athletes with persistent alteration of consciousness (Glasgow coma score of <15 more than 2 hours postinjury) or who vomit more than twice, imaging should be considered [24, 25, 26•]. Athletes with worsening clinical symptoms should also be considered [23]. Although likely not as common in most sideline evaluations anticoagulation and age >65 should also prompt consideration [24, 25]. There is little data on length of loss of consciousness as a need for imaging. In contrast to the adult decision rules the pediatric rules use loss of consciousness, varying from suspected to greater than 5 minutes, as a variable [24, 25, 26•]. More recent data,

Fig. 1 Approach to the athlete with traumatic cause of collapse

EAP- Emergency Action Plan

however, suggest that loss of consciousness in pediatric patients is not considered a significant risk factor for intracranial pathology [27]. One relatively simple rule that may help in the sideline evaluation of an athlete with head trauma is the Simplified Motor Score. This score has been validated in adults in the out-of-hospital setting making it potentially more useful for sideline coverage [28•]. This score use a 3-point scale, obeys commands=2, localizes pain=1, and withdraws to pain or worse=0. Any score other than 2 should prompt immediate transport for imaging; conversely athletes who can obey a command (Simplified Motor Score=2) are likely safe to observe in absence of other indicators previously discussed.

Cervical spine injuries are a leading cause of catastrophic injury in athletes while being a less common cause of death [1•, 2•, 4, 7, 8]. Because the mechanism often involves forces to the head evaluation of a collapsed athlete can be difficult. Spinal precaution should be initiated for any athlete who is unconscious or has neurologic complaints [29]. Athletes who regain alertness after initial loss of consciousness present a challenge to the evaluating providers. Earlier recommendation would suggest immobilization for any potential concerns about spinal injury, however, more recent protocols have questioned this practice [29, 30•]. This shift represents a change toward clinical evaluation of the athlete with a possible spine injury rather than the automatic application of spine precautions. Similar to head injury guidelines, Canadian C-spine and NEXUS have been develop to aid practitioners in the determination for the need of cervical imaging [30•]. There is limited data on the use of these rules for prehospital evaluation but recent data would suggest prehospital spinal precautions are performed

significantly more often than necessary [30•, 32–34]. The use of these rules on the sideline may be limited due to the variable they consider and the need for normal level of consciousness. For example, the Canadian rules use a dangerous mechanism, defined as a fall >3 feet or and axial load to the head, as a factor that would mandate imaging. Many sports injuries would fall into this category. Although overall the Canadian rules may have a slight advantage as a prediction rule the NEXUS criteria may be more useful on the sideline as they require a radiograph for any focal neurologic deficit, midline spinal tenderness, altered level of consciousness, intoxication, or distracting injury [31]. A distracting injury may be of concern in sports as well but more recent studies have shown that distracting injuries, including head trauma did not interfere with clinical evaluation of the spine and that physician judgment as to whether an associated injury is distracting is likely adequate [34–36, 37•].

Chest

The epidemiology of chest wall injuries in athletes is limited but in the general population thoracic trauma accounts for up to 25 % of fatalities [38]. Two pediatric study found sports to be the cause of blunt chest wall trauma approximately 1 %–4 % of cases and a review of thoracic injuries in rugby found injury rates of 8.3/1000 hours of participation although most of these injuries were not immediately life-threatening [39–41]. While many significant chest wall injuries, hemothorax, pneumothorax, and cardiac contusions are generally

not a cause of immediate collapse there are several conditions to be aware of when evaluating the collapsed athlete with chest wall trauma.

Comotio cordis is one of the potentially treatable causes of the collapsed athlete [9•, 42, 43]. Exact incidence is unknown and it appears to be most common in younger (<18) age group [42]. This event occurs when there is direct impact to the pericardium during the vulnerable period, just prior to T-wave, of the cardiac cycle. This impact, if timed correctly, will cause, most commonly, ventricular fibrillation although other abnormal rhythms may be seen as well [42, 43]. Athletes may present with a brief period of consciousness after the trauma prior to collapse [43]. Early reports showed high mortality rates from this condition but more recent data suggest early defibrillation significantly improves survival rates [9•]. Although some risk may be decreased by equipment changes, ie, soft baseballs, chest protectors do not seem to decrease the risk of commotio cordis [44••]. Therefore, this condition should remain at the top of the differential for any athlete who collapses after chest wall trauma regardless of the use of protective equipment.

Unfortunately other causes of immediate collapse after blunt chest wall trauma have worse outcomes. These injuries are fortunately rare but generally involve direct disruption of cardiac or vascular structure, ie, aortic rupture [38, 45–47]. Although rare in sports case reports have been published but the majority of these injuries require high energy and generally occur in accidents involving motorized vehicles, however, other sports such as skiing may generate similar forces. Unfortunately, mortality from these injuries is very high but some injuries may be repairable [38, 47]. Risk factors for internal injury to vascular structures after chest wall trauma are not well defined but multiple rib fractures, particularly higher ribs (above 9) with a high energy mechanism should raise suspicion [47, 48].

Cardiac contusions, hemothorax, pneumothorax, and pulmonary contusions are other potential injuries from blunt chest trauma but do generally not cause immediate collapse. These injuries can lead to delayed cardiac arrhythmias and oxygen perfusion issues so any athlete with persistent or worsening chest pain or shortness of breath after blunt chest trauma should be evaluated further [43, 44••]. Although relatively rare, tension pneumothorax is a true emergency. This condition occurs when the air leak of the affected pleural space creates enough pressure to push the mediastinum away from the injured side leading to vascular compromise [49]. The trachea is classically deviated away for the affected side and there may be jugular venous distention accompanied by hypotension. Immediate decompression is indicated and is one of the few prehospital interventions that should be undertaken for this suspect condition [49]. Needle decompression may not always be successful so transport to a medical facility should not be delayed if needle is not available [50].

Abdomen

Significant abdominal injuries are relatively rare in sports but splenic injuries may present with late collapse in an athlete. The spleen is the most commonly injured organ and while acute collapse is rare late presentation of syncope or presyncope is possible [51•]. Because trauma may be relatively innocuous suspicion for this injury should be maintained in athletes complaining of abdominal pain—particularly left upper quadrant. Diagnosis is not always clinically apparent as young athletes may maintain normal pressures even in the presence of extensive internal blood loss so transport should not be delayed for those with suspect injury. Athletes who present with hemodynamic compromise should be stabilized and transported for further evaluation [51•].

Conclusions

Fortunately life-threatening blunt trauma injuries are rare in sporting activity. Despite this it is imperative that the sports medicine team have an updated emergency action plan. This plan should include early access to an automated external defibrillator and early activation of emergency services as these have been shown to improve patient outcomes in blunt traumatic injuries. Because there is sometimes difficulty in the assessment of cause, direct or indirect, in the collapse athlete the medical team should take a standard approach being mindful of the potential causes of this condition.

Compliance with Ethics Guidelines

Conflict of Interest Matthew Gammons reports he is an Associate Editor for Primary Care Sports Medicine. Sports Health: A Multidisciplinary Approach.

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- Of major importance

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