



Case report

Pulmonary contusion with hemoptysis from lacrosse ball strike: A case report

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ABSTRACT

Lacrosse, a sport of increasing popularity, is played with netted sticks and a firm rubber ball propelled at speeds frequently reaching over 100 miles/hour. While lacrosse injuries have been previously described, little published literature exists on lacrosse balls causing pulmonary contusion. We present a case of a 17-year-old male lacrosse player athlete who suffered a lacrosse ball strike to the left posterolateral chest, leading to a clinical presentation of local bruising, shortness of breath, and hemoptysis. Despite delayed arrival to the emergency room, where imaging revealed pulmonary contusion, multidisciplinary supportive management led to favorable clinical outcome with no residual effect on athletic ability and quality of life. Although pulmonary contusion may be a rare injury in the setting of thoracic trauma from lacrosse ball strikes, prompt evaluation and a high index of suspicion can rule out more life-threatening processes and ensure an excellent clinical prognosis.

1. Introduction

Lacrosse is a ball and netted stick sport of increasing popularity amongst amateur grade school, high school, and college athletes. With total estimated national participation increasing over 200 % in the last two decades, lacrosse stands among the fastest-growing team sports in the United States (US). According to USA Lacrosse, more than 800,000 players participated in the sport in 2018, underpinned by a growth in player base across all levels. Professional lacrosse has also seen a major expansion in the past decade with increased attendance and viewership across national and international tournaments [1]. Currently, there are 92 member-countries represented by World Lacrosse, a two-fold increase in the number of national federations since 2008. Moreover, the International Olympic Committee has recently approved the inclusion of men's and women's lacrosse for the 2028 Summer Olympics, poising the sport for continued growth, accessibility, and impact [2].

Lacrosse balls used in play have a standard mass of 5.0 oz, or approximately 150 g, and can be propelled by high school, college, or professional players at over 100 miles per hour [3]. The resulting kinetic energy is approximately 150 J and resultant impacts can transmit sufficient energy to cause fractures and deep soft tissue "shock wave-like" injuries. Soft tissue injuries to the extremities and trunk are common, but serious injuries like chest wall fractures, pulmonary contusion, hemopneumothorax and commotio cordis may

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also occur.

In this context of non-penetrating projectile injury, the expansion of high-speed shock waves from the site of impact generates shearing and tensile forces, damaging local tissue. Biomechanical studies have previously recorded the effects of such shock wave effects of missiles on soft tissue, specifically related to their mass and velocity. Impacts involving high-speed and high-mass projectiles, imparting considerable kinetic energy, were shown to result in faster surface waves with increased resulting tissue strain [4].

Accordingly, tissue-level strain effects in swine models have been previously reported as a robust surrogate for pulmonary contusion [5]. Despite this, there exists very little published literature on the clinical presentation and management of pulmonary contusion within lacrosse players. Here, we present a case of a lacrosse ball strike to the left posterior-lateral chest wall that produced pain, shortness of breath, signs of soft tissue contusion, and hemoptysis without pneumo-/hemo-thorax in a healthy young male. Recommendations for assessment and triage on the sideline are made to reduce the chance of delayed adverse events.

2. Case presentation

A 17-year-old male, a healthy high-school senior, with no pertinent past medical history or genetic information, was playing in the midfield position during a lacrosse match in a state tournament. Out in the field, he was struck by a lacrosse ball to the left posterior lateral chest wall while crossing in front of the opposition goal. The player immediately fell to the ground with pain to the left posterior chest, became short of breath, and within a few minutes, began to cough up bright red blood. He was assisted to the sideline by trainers where he was assessed, and his parents were promptly called over for assistance. With no nearby local hospitals or ambulances on-site, the sideline personnel provided the parents with instructions on transporting their son to the nearest emergency room. During the car trip (about 1 hour in duration), which was complicated by heavy traffic, the player continued to cough up teaspoon amounts of clotted blood and remained in distress with shortness of breath.

On arrival at the local emergency room, the patient continued complaining of left-sided posterior chest pain with associated shortness of breath and hemoptysis. There, the patient presented mildly tachycardic (104 bpm) but was otherwise normotensive (114/68 mmHg) with a respiratory rate of 18 breaths per minute. Clinical examination revealed localized swelling and tenderness, with central pallor and surrounding erythema, at the site of lacrosse ball impact. There was no crepitus or paradoxical chest wall movement, and the trachea was midline. After pulse oximetry and ECG monitoring were performed, the patient underwent chest X-ray imaging. His initial plain chest X-ray demonstrated no rib fractures, pneumothorax, or left chest cavity opacification. Treatment measures at the emergency room included administration of oxycodone (10 mg every 12 hours) for pain management, supplemental oxygen by face mask, and intravenous hydration. A CT scan was ordered because of continuing hemoptysis, which demonstrated a left lower lobe pulmonary contusion without pneumothorax or hemo-thorax (Fig. 1).

On the advice of the emergency room physician, the player was transferred to a regional trauma center in the evening, where overnight observation was advised. No interventional procedures were considered necessary. His therapeutic care was resumed without change, which was tolerated well and alleviated the patient's severity of pain successfully. A follow-up chest X-ray, performed 24 hours after the time of injury, was unchanged with no evidence for pneumothorax. Subsequently, the player was discharged home in the afternoon following the injury, with no additional follow-up. He remained in the local region until 2 days after the injury, and thereafter flew home on a commercial airline flight uneventfully. During the course of recovery, no residual episodes of hemoptysis or other medical complications (e.g., pneumonia) were reported.

Six weeks later, the player was able to return to his athletic activities without difficulty. He would proceed to enter into men's college-level lacrosse within the National Collegiate Athletics Association (NCAA) for 3 years, with no known long-standing effects on athletic activities or pulmonary function.

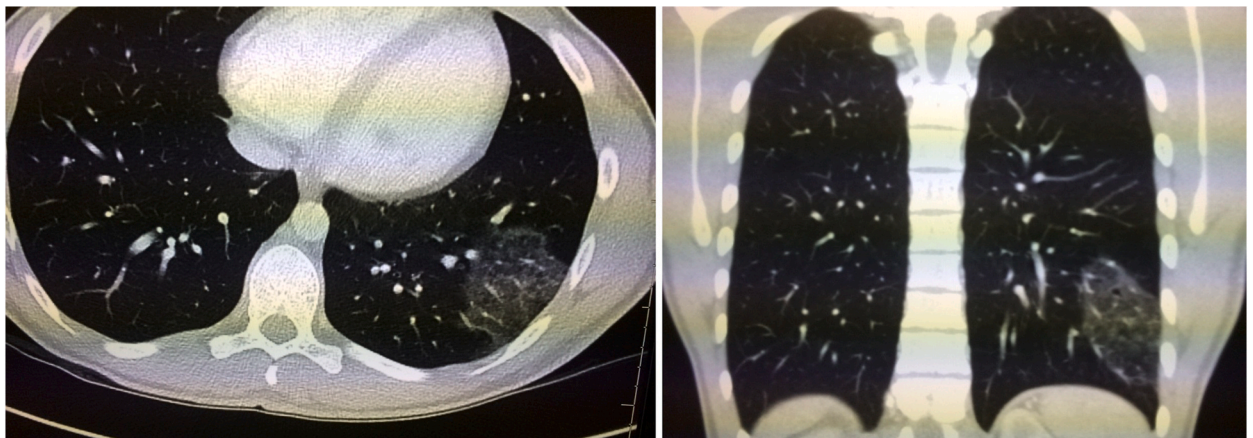


Fig. 1. Computed tomography scan, lung windows, in both axial (left) and coronal (right) planes showing focal, non-segmental areas of parenchymal opacification at the site of injury, consistent with pulmonary contusion. In the axial plane, a small rim of pleural sparing is visible, a typical feature in pulmonary contusion.

3. Discussion

Lacrosse is a contact sport that, for men, requires wearing of protective equipment including a helmet with face mask, shoulder pads, elbow pads, gloves, and athletic cup. Lacrosse ball impacts commonly cause soft tissue contusions of the extremities and trunk, but serious chest wall impacts causing cardiac dysrhythmias, rib fractures, pneumo-/hemo-thorax, or pulmonary contusions are rare. While injuries in lacrosse players have been previously described in the literature, little to no published literature has been described on lacrosse injuries causing pulmonary contusion with hemoptysis. A search of PubMed, Cochrane CENTRAL, and Scopus databases on November 11, 2023, using the search string ((lacrosse) AND (('pulmonary AND contusion') OR (hemoptysis))) indicated no relevant articles on the topic.

Pulmonary contusion without rib fracture is presumably caused by “shock wave” energy as a result of the kinetic energy transfer from the ball to the chest wall. On impact, damage to the alveolar capillaries results in the accumulation of blood and fluids into the lung tissue, leading to alveolar collapse and subsequent hypoxia [6]. Clinically, pulmonary contusion should be suspected when there is a history of chest wall lacrosse ball strikes accompanied by local pain, redness, and swelling, with shortness of breath and hemoptysis. Although the injury presented in this case resulted in an uncomplicated case of pulmonary contusion, this type of trauma and the presence of hemoptysis can indicate a significant, life-threatening lung and/or chest cavity injury. Therefore, we highlight guidelines and recommendations for appropriate sideline evaluation, support, and triage from athletic personnel, coaches, team physicians, and parents (Tables 1 and 2).

Sideline evaluation and management should be based on basic life support (BLS), and provided expertise is available, Advanced Trauma Life Support (ATLS). Evaluation should include examination of vital signs, breath sounds, and tracheal position to exclude a concomitant traumatic pneumothorax. Examination of the chest wall for deformity or instability may lead to suspicion for rib fractures. Supportive care at the time of injury may require the use of supplemental oxygen. Significant hemoptysis, i.e., more than 5 cc/one teaspoon, indicates the likelihood of a greater volume of pulmonary contusion or a bronchial injury, which should prompt EMS services for transportation to an emergency room facility. Caution is indicated even though an implosion effect from blast injury is low. Defibrillators should be immediately available in the field for use in the case of blunt cardiac injury such as commotio cordis. Namely, previous literature has shown that balls propelled at only 30 miles per hour can induce ventricular fibrillation in a swine model [7]. This is much slower than the expected velocities during a lacrosse game.

Symptoms of pulmonary contusion usually develop within minutes in severe contusion, while clinical features may develop gradually over 24–48 hours in more mild cases [8]. These symptoms vary depending on the severity of the injury. Mild cases may be asymptomatic, while severe cases may lead to hypoxemia, hypercarbia, tachypnea, and dyspnea [9]. Radiographic evaluation with chest x-ray and computed tomography helps identify concomitant injuries such as pneumothorax, hemothorax, and rib fractures. If a tension pneumothorax is missed on evaluation, the patient may worsen rapidly. Likewise, a missed hemothorax can lead to fibrothorax and trapped lung, requiring major surgical intervention for restoration of pulmonary function. This is why amateur and professional lacrosse sideline personnel need to be aware of the possibility of complications from pulmonary contusion when a player is observed to exhibit signs of respiratory distress with hemoptysis after a chest wall lacrosse ball strike. Mobilization of emergency medical services personnel to assess, treat, and transfer the player to a medical facility is key to preventing an unrecognized catastrophe.

With appropriate management, the prognosis of pulmonary contusion is excellent. Most cases will heal in five to seven days. Some patients, however, may progress to respiratory failure, ARDS, or pneumonia [10]. Severe cases can lead to chronic pulmonary disease, decreased functional residual capacity, and pulmonary fibrosis [11]. Identifying patients at risk of pulmonary contusion is crucial to managing them promptly and appropriately [12]. To that end, the present case describes a pulmonary manifestation of chest wall trauma, which is notably rare in lacrosse injuries. Previous injury surveillance reviews have identified the lower leg/ankle/foot as the most common site of injury among lacrosse athletes, followed by the face/head and knees [13]. Contrarily, chest wall trauma with pulmonary complication from lacrosse ball strike is quite uncommon and has remained poorly described in the literature. Although this case was uncomplicated from pneumo-/hemo-thorax, this domain of injury carries serious aforementioned risks of adverse short- and long-term medical effects. Here, we indicate success from informed sideline triage and prompt emergency transport towards injury risk mitigation in the event of chest trauma and subsequent hemoptysis from lacrosse ball strike.

With lacrosse's rising participation and inclusion in international events, most notably the upcoming 2028 Summer Olympics, it remains an organized team sport of ever-increasing significance. In the United States alone, over 200,000 high-school players

Table 1
Spectrum of Lacrosse Ball Injuries to Chest Wall and/or Lung Causing Hemoptysis.

Injury	Clinical Features
1. Chest wall soft tissue contusion	Local pain, redness, swelling, mild shortness of breath
2. Rib fracture without pneumo-/hemo-thorax	Local pain, redness, swelling, mild shortness of breath
3. Rib fracture with pneumo-thorax	Local pain, redness, swelling, progressive shortness of breath, can produce tension pneumothorax and cardiovascular collapse
4. Rib fracture with pneumo-/hemo-thorax	Local pain, redness, swelling, progressive shortness of breath, can produce tension pneumothorax and cardiovascular collapse
5. Pulmonary contusion	Local pain, redness, swelling, moderate shortness of breath, hemoptysis
6. Pulmonary contusion with rib fracture	Local pain, redness, swelling, progressive shortness of breath, hemoptysis, can produce tension pneumothorax and cardiovascular collapse

Table 2
Recommendations for sideline triage and management of lacrosse ball strike.
EMS, emergency medical services

<u>Steps in Assessment</u>	<u>Recommended Action</u>
Initial Management	Call national/local emergency services Focus on Basic Life Support (BLS): Airway Breathing & Ventilation Circulation Calm the player
Further Management	Advanced Trauma Life Support (ATLS) Protocol (if expertise available) Airway Breathing & Ventilation Circulation Disability Exposure
Preparation for Transport	Remove upper body playing gear, if possible, and may apply local cold compress to impact site Continue recording of vital signs Notify coaches and parents of transport Report details of injury and vital signs to EMS team

participated in lacrosse athletics programs during the 2022-23 school year [14]. This poses a highly promising public health benefit, as organized team sport participation has been linked to improved physical and mental health outcomes in children and adolescents [15]. Nonetheless, there also exists an appreciable risk and burden of injury in the sport of lacrosse, including chest wall traumas with rarer pulmonary pathology. Through awareness of the manifestations of pulmonary contusion and its sideline recommendations as outlined herein, all involved sideline personnel can promote optimal clinical outcomes among lacrosse athletes.

4. Conclusion

In the setting of lacrosse ball strikes, pulmonary contusion may be suspected where there are findings of chest wall soft-tissue contusion (local pain, redness, and swelling) accompanied by shortness of breath and hemoptysis. During sideline triage, an informed plan and high index of suspicion is essential to manage life-threatening pathologies that are possible with thoracic trauma. For uncomplicated cases of pulmonary contusion, close observation and supportive care can promote an excellent clinical prognosis.

Ethics statement

This study was conducted in accordance with the Declaration of Helsinki (2013). Written informed consent was obtained from the patient for publication of information presented in this report, including any accompanying images or other data.

Disclosures of interest

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Diversity, inclusion and equity statement

We support diverse, equitable, and representative conduct of research.

CRedit authorship contribution statement

Ernesto F. Marin: Writing – review & editing, Writing – original draft. **Ahmad Ozair:** Writing – review & editing, Writing – original draft. **John DeRosimo:** Visualization, Investigation. **John Candela:** Resources, Investigation. **Michael W. McDermott:** Writing – original draft, Supervision, Project administration, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing

interests: Michael W McDermott reports a relationship with Stryker Instruments that includes: consulting or advisory. Michael W McDermott reports a relationship with ZAP Surgical Systems, Inc. that includes: consulting or advisory. Michael W McDermott reports a relationship with Deinde Medical that includes: consulting or advisory. Michael W McDermott reports a relationship with Light Helmets that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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