

Battlefield, Bullets and Bugs: the Vicious Circle in Gunshots

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Abstract

Battlefield gunshot wounds inflict severe damage by impact and penetration causing polytrauma and hemorrhage, resulting in high morbidity and mortality than explosive injuries. Two cases of ballistic polytrauma due to multiple gunshot wounds resulting in multiple injuries underwent battlefield care, strategic evacuation, and surgical and critical care interventions through various echelons of healthcare, although succumbed to ensuing complications for which they were investigated post-mortem. The vicious circle in gunshots from battlefield to tertiary care comprises ballistic polytrauma, hemodynamic compromise, delayed evacuation, large soft tissue defects, critical care, and secondary infections. Post-mortem autopsy and virtopsy can discern terminal ballistics and complications thereof for better management of gunshot polytrauma in future.

Keywords: Gunshot, ballistic trauma, *Klebsiella pneumoniae*, sepsis, virtopsy

Introduction

Battlefields have long witnessed gun-propelled bullet-shots, which are extensively damaging subsonic or supersonic projectiles propelled by explosive force. The terminal ballistics forms a complex interplay of severely damaging impact and penetration causing polytrauma and hemorrhage, resulting in high morbidity and mortality than explosive injuries (1). We present two cases of polytrauma due to multiple gunshot wounds in the battlefield, who underwent battlefield care, strategic evacuation, and surgical and critical care interventions through various echelons of healthcare, although succumbed to ensuing complications for which they were investigated post-mortem.

Case 1: Multiple Gunshot Wounds with Multiple Injuries

A 43-year-old military personnel sustained gunshot injuries over left side of arm, axilla and back along with shrapnel injuries

over right ischio-rectal fossa. After initial management, he was evacuated to a secondary care facility the next day where X-ray and non-contrast computed tomography showed multiple rib fractures, comminuted fracture of left humerus, and multiple splinters in the right gutta, intertrochanteric region, and anterior compartment of right thigh. Wound debridement was followed by four units of whole blood. He was initiated on mechanical ventilation under cover of antimicrobials, analgesics, and proton pump inhibitors. The next day, while serum creatinine was 7.5 mg/dl and serum potassium 8.1 mEq/L, he developed ventricular arrhythmia and was managed with continuous salbutamol inhalation and dextrose-insulin infusion. On air-evacuation to a tertiary care facility on fifth day post-injury on ventilator support, he was found to have moderate ascites, bilateral pleural effusion and hepatomegaly with grade I fatty liver on bed-side focused assessment with sonography in trauma. He continued to deteriorate with increasing creatinine levels despite hemodialysis, refractory metabolic acidosis and severe adult respiratory distress syndrome (ARDS) consequent to bilateral lung contusion, and *Klebsiella pneumoniae* bacteremia leading to sepsis. During the course of his illness, leucocytes increased from 10900 to 21060/mm³, with neutrophilic leukocytosis, left shift, toxic granules and nucleated erythrocytes. AST varied from 481-1330 IU/L, ALT from 85-138 IU/L, alkaline phosphatase from 43-113 IU/L, serum urea 43-129 mg/dl, creatinine from 4-9.9 mg/dl, serum potassium 3.9-5.8 mEq/L, and procalcitonin from 15-25 ng/ml. Other parameters were within normal limits. He succumbed following a cardiac arrest on 9th day post-injury. Autopsy revealed multiple pus discharging wounds exposing the underlying muscles and neurovascular bundles. Lungs showed bronchopneumonia. Pleural fluid and swab cultures from all gunshot wounds revealed multidrug resistant (MDR) *Klebsiella pneumoniae*. Cause of death was sepsis in a setting of severe ARDS with acute renal failure and refractory metabolic acidosis consequent to multiple gunshot wounds.

Case 2: Multiple Gunshot Wounds of Chest and Extremities

A young military personnel of 22 years having sustained multiple gunshot injuries to his right forearm, hand and leg along with left thigh and chest was air-evacuated to a secondary care facility and resuscitated with six units of packed red cells followed by wound debridement, antimicrobials, proton pump inhibitors, and frusemide infusion. Segmental comminuted fracture of right proximal ulna and fracture of third left metacarpal were found. Over the next five days, high fever and tachypnea, diminished

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breath sounds and bilateral crackles along with left lung opacities on X-ray led to initiation of continuous positive airway pressure. Hemoglobin reduced from 12.2 to 7 gm/dl, and leucocytes increased from 7600 to 17300/mm³. After air-evacuation to a tertiary care facility on sixth day post-injury, he had a heart rate of 150/min, left pleural effusion, hemoglobin 3.5 gm/dl, leucocytes 21500/mm³, neutrophilic leukocytosis, prothrombin time 19.6 with INR 1.6, 32% band forms with left shift. He was initiated on mechanical ventilation and transfused eight units of packed cells along with diuretics. Pus filled gunshot wounds measuring 7 by 3 cm over left side of chest wall and axilla, 16 by 8 cm over right forearm, and 18 by 6 cm over left thigh exposed the underlying muscles and neurovascular bundles. Collection in intramuscular pockets in left thigh, localized hematoma and contused muscles were debrided and forearm was stabilized by elbow spanning external fixator. Wound swab and blood cultures revealed MDR *Klebsiella pneumoniae* for which both tigecycline and colistin were added, despite which he developed sepsis along with multiorgan dysfunction. Band forms reduced to 25% though neutrophilic leukocytosis persisted, serum urea varied from 41-52 mg/dl, creatinine 0.8-1.6 mg/dl, procalcitonin 36 ng/ml, AST 315-20 IU/L, ALT 189-28 IU/L, alkaline phosphatase 116-96 IU/L, and amylase 121-65 U/L. Other parameters were within normal limits. He developed sudden respiratory distress, deteriorated rapidly and succumbed to cardiac arrest on 12th day post-injury. Autopsy revealed bronchopneumonia. Heart blood and swab cultures from all gunshot wounds revealed MDR *Klebsiella pneumoniae*. Cause of death was sepsis in a backdrop of multiple gunshot wounds.

Discussion

These patients survived gunshot inflicted polytrauma and ensuing complications through strategic evacuation, damage control surgery and resuscitation (DCS and DCR), although succumbed to respiratory complications and disseminated MDR *Klebsiella pneumoniae* infections leading to sepsis. Early less aggressive surgical debridement and empirical antimicrobials result in better outcome in 71% patients although the incidence of infection remains at 35-40%. Widespread infection, respiratory distress, and acidosis are known to occur in 3-10% of trauma patients (2). The Syrian Civil War from 2011-2014 witnessed 15.51% deaths from sepsis in gunshot injuries (3). Treatment of disseminated infections caused by MDR *Klebsiella pneumoniae* susceptible only to Tigecycline and Colistin may lead to development of antimicrobial resistance (4, 5).

Gunshot polytrauma in the battlefield can be challenging on both logistic and clinical axes. Terrain, weather, communication, capability and patient's condition affect foot, vehicle and air-evacuation from mountains and jungles. The terminal ballistics and complications can be discerned by post-mortem investigations such as autopsy and virtopsy or digital autopsy. Autopsy studies can better delineate projectile action crushing through tissues in ballistic penetrating trauma but are fret with safety issues (6). Virtopsy offers better visualization of gunshot wound entry and exit, hidden objects in the body such as embolized, migrating or frangible bullets and splinters, traumatic bone injuries, air in tissue or vascular spaces, and anthropological characteristics (6-8). Virtopsy is rapid, facilitates a nondestructive approach, 3D reconstruction and digital records, reduces the risk of transmissible infections and confers protection from hazards such as exploding incendiary bullets. Virtopsy may be of immense help in rapid post-mortem investigation of brought dead cases or even mass casualties from operational areas wherein data can be transmitted for clinicopathological, radiological and forensic analysis at apex

centers. Virtopsy is routinely conducted in the developed world, though yet to be started in the developing world for post-mortem investigations and yet to become legally acceptable. Combination of virtopsy and autopsy, including dental autopsy for oromaxillofacial injuries, in post-mortem investigations can be targeted for clinicopathological, forensic and ballistic studies (6).

Conclusion

The vicious circle in gunshots from battlefield to tertiary care comprises ballistic polytrauma, hemodynamic compromise, delayed evacuation, large soft tissue defects, critical care, and secondary infections. Post-mortem autopsy and virtopsy can discern terminal ballistics and complications thereof for better management of gunshot polytrauma in future.

Conflicts of Interest: None

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